

National Park Service
Inventory and Monitoring Program

Mid-Atlantic Network
Inventory Study Plan For:
Vertebrate and Vascular Plant Species

October 1, 2001

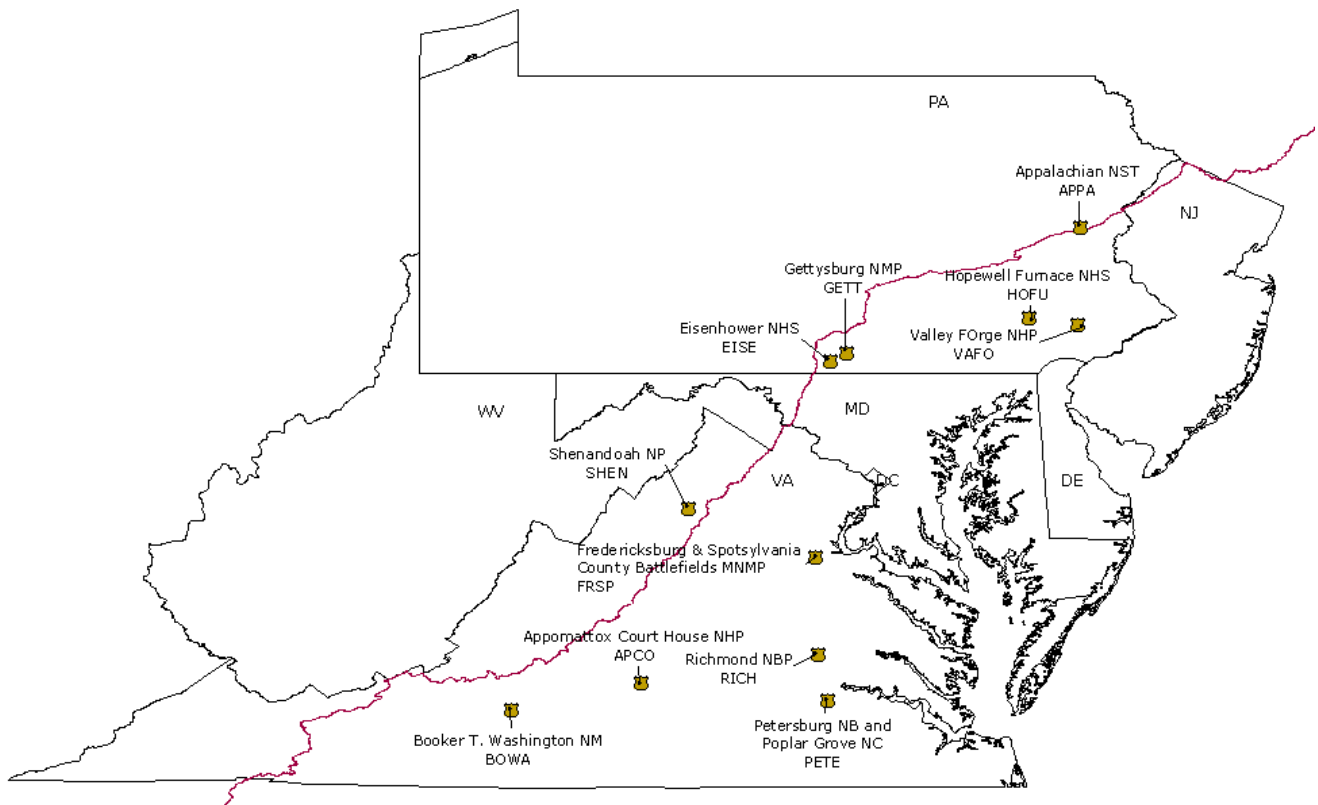


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SECTION I-INTRODUCTION

Habitat loss and fragmentation are two of the most significant threats to biological diversity today (Primack, 1993). As large tracts of public lands, such as national parks, become more insular from increased fragmentation due to agricultural development, urbanization, or other land use changes, these lands will become increasingly valuable for the long-term maintenance of floral and faunal diversity as well as the functional integrity of landscapes and ecosystems in the United States (Ambrose and Bratton 1990, Yahner et al. 1995). As one of the largest land managers in the United States, it is crucial that the National Park Service (NPS) first determines the extent and then maintains existing biological diversity within its parks.

Since the establishment of the National Park Service, natural resource data has been collected by various sources, university scientists, scientists within the parks, and organized groups such as state breeding bird atlases, state herpetological atlases and other similar watch groups. Although this biological information exists for many of the parks, much of it has never been compiled and reviewed by the Service. Over the past decade, the National Park Service has been working to establish what is now called the Inventory and Monitoring Program (I&M program). The principal and simplified functions of this program are to gather existing as well as new information about the natural resources in the parks and to make that information easily available at different levels, to park resource managers, the scientific community and the public. Another function of the I&M Program is to develop long-term techniques and strategies for monitoring the diverse expanse of ecological communities that make up the National Park System. A basic component of this program is the creation of databases that can store such an enormous amount of information and at the same time be user friendly and accessible. The National Park Service has created three such databases, NPSpecies to store information about the existing and historical records of species in each park, the NRBIB a bibliographic database to house all existing natural resource publications for each park, and the Dataset Catalog which references park spatial and electronic data sets.

For park managers to effectively try to maintain the biological diversity and ecological health of their parks, they must have a basic knowledge of what natural resources exist in parks as well as an understanding of those factors that may threaten them. One of the first goals of the I&M program will be to establish baseline biological inventories for vascular plant and vertebrate species in order to provide reliable species lists, a fundamental tool for management. The program will also begin to gather relative abundance and distribution information for species of special concern. Detailed information on exotic invasive plant species for example, as well as on rare and threatened species can enable more effective management practices. The simple knowledge of what and where species exist in the parks is crucial in making decisions on such things as building new trails, buildings and restoring cultural landscapes. Phase II of the I&M program will involve developing long-term monitoring programs to efficiently and effectively monitor ecosystem status and trends over time within the parks. Without the baseline information that will be gathered in Phase I, such long-term monitoring programs can not effectively be established.

In order to reduce costs and increase efficiency, the National Park Service has clustered parks into I&M Program "Networks" so that data acquisition might occur simultaneously at several locations. The basic data themes that have been identified for the Phase I natural resource inventory represent the recommended minimal data set for all natural resource parks. These data theme descriptions can be found in the Inventory and Monitoring Guidelines for Biological Inventories (National Park Service, 1999). Priority biota groups include:

- ◆ vascular plants
- ◆ vertebrates
- ◆ federally and state listed threatened and endangered species
- ◆ species of special concern within the park, including endemic, nonnative, and other species identified by legislation.

1.1 Goals and Objectives of the Mid-Atlantic Network

The Mid-Atlantic Network Inventory Study Plan is a detailed plan for completing inventories of vascular plant and vertebrate species within eleven National Parks in the Northeast Region. Six of these parks are in the state of Virginia and four are in Pennsylvania. The Appalachian Trail, also assigned to this Network crosses fourteen Northeastern states. This plan reflects the goals and objectives of the Mid-Atlantic Network within the context of the National I&M Program goals and objectives listed below:

- ◆ To document through existing, verifiable data and targeted field surveys the occurrence of at least 90 percent of the species of vertebrates and vascular plants currently estimated to occur in each park.
- ◆ To describe the distribution and relative abundance of species of special concern, such as Threatened and Endangered species or exotic species occurring within park boundaries.
- ◆ To provide the baseline information the parks need to develop and implement a general monitoring strategy once inventories have been completed.

This document describes the plan of action that will be taken over the next four years to implement biological inventories in the Mid-Atlantic Network. This plan has been developed after discussion with park resource managers within the network, a scoping workshop held in Virginia, meetings with the Pennsylvania parks, input from many local taxa experts, and a review of existing inventory data. With the National Program goals in mind, the Mid-Atlantic Network began to develop their own plan. The Network hopes to accomplish the following three goals over the next four years.

GOAL 1

Data Management and relational database development of existing, large, network data sets.

GOAL 2

To conduct baseline presence/presence not detected inventories on those taxonomic groups identified as having incomplete data.

GOAL 3

To determine the distribution and abundance of targeted groups of vertebrate and vascular plant species identified by the Network.

Tasks necessary to meet the goals of the National Program became the focus for the development of this Network plan. For example, in order to meet the 90 % goal, calculating the percentage of existing, documented species in each park is necessary. To do this, parks need an up-to-date species database that contains verified records and associated, credible documentation. With the exception of SHEN, verified, accurate and up-to-date species lists are not yet available for the Mid-Atlantic Network parks. Database population and development

became a priority for the Network. During the data mining process, it was clear that some parks, particularly the VA parks, have had little or no inventory work done on entire taxonomic groups. Completing baseline inventories on those species group with little or no existing data became the Network's second priority. And finally, for those parks with baseline data complete, in particular the PA parks, identifying groups of species in which distribution and abundance information would be useful for future management practices in the parks became goal three.

SECTION II-MID-ATLANTIC NETWORK PARK DESCRIPTIONS

The Mid-Atlantic Network includes eleven national parks. The parks range in size from approximately 224 to 196,000 acres and are located across two states, Virginia and Pennsylvania, except for the Appalachian Trail which is 214,000 acres and located across 14 states (Table 1). All of the parks in this network cover a wide range of temperate forest, from coniferous to mixed deciduous. They also include a wide range of habitat types, from old field to talus slopes.

This network varies greatly amongst its parks in terms of how much baseline natural resource inventory data has been collected. All of the PA parks, GETT, HOFU, EISE and VAFO have had or are in the process of completing baseline vertebrate inventories. Shenandoah, because it is a prototype monitoring park, and because it was originally designated a park for its intrinsic natural rather than cultural value, has had a great deal of natural resource inventory work completed there. On the other hand, the Virginia parks such as BOWA, PETE, RICH, FRSP, and APCO have had very little and in some cases, no vertebrate and vascular plant inventory work done in them.

Table 1. Parks in the Mid-Atlantic Network.

Park	Code	State	Est.	Acres	Ha
Booker T. Washington NHS	BOWA	VA	1956	224	91
Richmond National Battlefield Park	RICH	VA	1936	764	309
Appomattox Court House NHS	APCO	VA	1954	1,743	705
Petersburg National Battlefield Park	PETE	VA	1962	3,140	1,271
Fredericksburg and Spotsylvania NMP	FRSP	VA	1927	7,100	2,873
Shenandoah NP	SHEN	VA	1935	196,149	79,380
Gettysburg National Military Park	GETT	PA	1985	5,990	2424
Eisenhower National Historic Site	EISE	PA	1967	690	279
Hopewell Furnace National NHS	HOFU	PA	1985	848	343
Valley Forge National Historical Park	VAFO	PA	1976	3,466	1,403
Appalachian National Scenic Trail	APPA	14 states	1968	214,315	86,732

Booker T. Washington NHS (BOWA)

Hardy, VA

Visitation 22,623

Booker T. Washington National Monument is comprised of forests, open woodland and meadow, hayfields, pasture, demonstration cropfield, garden, and maintained turf. Agricultural and forested lands cover more than 80% of the park's land base. The forests are a mosaic of vegetation types. Much of the forests appear to be 30-100 years old. Most forests in the park appear to have developed following agricultural abandonment. They possess a unique mix of higher elevation Central Appalachian mixed deciduous forest species, like Table Mountain Pine, and various bottomland species like Southern Red Oak.

The park contains numerous small streams including Gill's Creek and its three tributaries, Jack-O-Lantern Branch and two unnamed streams. There are also five cold springs located in the park.

Agricultural land in the park contains approximately 22 acres in pasture, 38 acres in hayfields, and 2 acres under demonstration crop cultivation. Encroachment of weeds, undesirable grasses, and woody vegetation constantly attempts to compromise the integrity of the hayfields and pastures.

Changes in patterns of land use are occurring on all lands adjacent to and surrounding the park at an accelerated rate. This is due primarily to the sale and development of land around nearby Smith Mountain Lake. Smith Mountain Lake is a hydroelectric project with approximately 600 miles of shoreline. In the past, most of the land in the area had been primarily agricultural farmland and was sparsely populated. With people and businesses moving into the area, farmland and forests have been fragmented and sold into lots for residential and business development. The surrounding area is being developed in a checkerboard pattern with single residential and whole subdivisions being established in random order as land is divided, sold, and rebuilt upon. Recent occurrences near the park include land being put up for sale along two boundaries of the park and a clearcut forestry operation within the viewshed of the park on land that is currently for sale.

As land use changes occur, the undisturbed natural ecosystems at Booker T. Washington National Monument become more of a virtual oasis. Forested areas of the park have remained unchanged for over one hundred years, after being abandoned for agricultural uses. NPS resource management specialists and scientists conducting site assessments at the park recently have determined the park's forests to be "geographically unique" in that they host plant and tree species that are now considered to be somewhat out of their normal home ranges. The forest contain species which are commonly found in the mountains to the west as well as species that are found in the flat Piedmont areas to the east of the park. As farmland and forests in the areas surrounding the park are fragmented and destroyed, the park's forestland will continue to become more unique and in need of attention and protection. The park needs to know what plant and animal species live within park boundaries now, the condition and size of their populations, and how land use changes in the surrounding areas will affect populations as other plants and animals migrate in and out of the park.

Management Issues:

- Land use changes around the park and its effects on park species.

- Cultural Landscape Management
- Viewshed analysis and protection
- T&E Species
- Air and water quality
- Exotic species
- Visitor Use and Recreation (Environmental education, facilities development, trail development with interpretive media and interpretive programs)

Richmond National Battlefield Park (RICH)

Richmond, VA

Visitation 87,957

The park is presently made up of eleven separate units totaling 764 acres and straddling three counties (Hanover, Chesterfield and Henrico) and the City of Richmond. However, the park will be accepting 1300 additional acres in the next year. Eight of the park's present units contain natural habitats, while the remaining three consist only of historic buildings and/or visitor centers. Surrounding land uses consist of residential developments, industrial and rural homes and farmland. The park presently has 40 acres of land leased for agriculture and approximately 70 additional acres of managed fields. The remaining acreage of the park consists mainly of forest habitat. General forest types transition from mixed hardwood to pine to mixed oak communities depending primarily on past land use (the majority of the park's acreage was historically cleared for agriculture) and the stage of succession. Forest dominants include American beech, sweetgum, tulip poplar, loblolly pine, black oak, willow oak southern red oak, white oak, red maple, American holly and blackgum. The park presently contains approximately 75 acres of riparian wetland. Although the majority of the park's wetlands are forested, several areas have opened up due to beaver activity.

Management Issues:

- Managing earthworks to minimize erosion in areas of various vegetative coverage (full forest coverage, forest canopy coverage only, and open field)
- Restoration and maintenance of historic landscape consisting of mostly open lands, and related environmental concerns associated with forest removal (habitat destruction, erosion and sedimentation, etc.)
- Water quality in areas surrounded by agriculture, industry and residential developments
- Restoration and maintenance of forested buffers along watercourses to uphold the Chesapeake Bay Agreement
- Environmentally sound farmland and field management

Appomattox Courthouse NHP (APCO)

Appomattox, VA

Visitation 198,665

Appomattox Court House NHP encompasses 1,743 acres and is located 3 miles northeast of the town of Appomattox (1990 population 12,298) and 18 miles east of the city of Lynchburg (1990 population 4,053,488). The park is situated within the Piedmont physiographic province, characterized by gently rolling topography, deeply weathered bedrock, and few solid outcrops. The park lies astraddle the Chatham fault on a body of transported rock known as the Smith River allochthon, composed of metamorphic schists and gneisses, typical

of the Virginia Piedmont. Soil types derived from schist and gneiss parent materials tend to be deep, rich in weathering products (clay and iron oxides), and very red in color. The 16 soil types within Appomattox Court House NHP are primarily clay, silt, and sandy loams which support a variety of plant and animal species. Elevation within the park ranges from approximately 600 feet above sea level at the Appomattox River to about 830 feet along the western park boundary.

Vegetation dominates the park's cultural landscape. Spatial arrangement of woods and fields affects interpretation of the historic scene and recreational activities. The park is approximately 70% wooded (1159 acres) and 30% (579 acres) open fields (including historic village). Open fields outside the historic village are managed primarily through the Historic Leasing Program. As stated in the General Management Plan, "the purpose of these permits is to maintain open field areas in a manner resembling those of 1865" (p. 23). Currently, approximately 68 acres are managed in hay and 427 acres are leased as pasture for cattle. Stocking rates for cattle are adjusted to maintain a 3 inch stubble. Little is known about the impacts of agricultural activities on the natural environment and a current Soil and Water Conservation Plan is not in place. Open areas in and around the historic village are mowed weekly (approximately 32 times per year) by park staff and other areas maintained by park staff are mowed approximately 16 times per year (every 2 weeks April-November).

Today a significantly greater acreage of land is maintained as woodland compared to the 1865 landscape, however the GMP (1977) states that "it is not necessary to return to the tree lines of 1865..." (p.22). The stated goal for management of park woodlands is to manage "in a manner that optimizes their value as a natural visual barrier between the historic village and adjacent lands to the south and east" (GMP 1977). A *Forest Management Plan* (1986), developed by Virginia Polytechnic Institute and State University, describes much of the forested landscape at Appomattox Court House NHP as going through "a successional transition from one seral stage to the next. As a result, natural tree mortality, disease, insect infestations and wildfire threaten the vitality and integrity of the landscape resource of the park" (p. ii). Currently, a Fire Management Plan has not been developed, no monitoring of forest health is occurring and the *Forest Management Plan* has never been implemented.

At least 72 species of trees and shrubs and 60 species of herbaceous plants and vines have been identified within park boundaries (Morris Arboretum 1997, Lund unpubl., Hamilton et. al. 1986). No federally or state listed threatened or endangered species or significant natural communities have been identified at the park although as more systematic surveys of park resources are completed this number may change (Ludwig and Pague 1993). A level 1 formation level vegetation map began in 2000 in cooperation with North Carolina State University.

Currently, no information exists related to the presence and distribution of park fauna.

Approximately, 8.4 miles of the Appomattox River, including one main tributary (Plain Branch Run; 2.9 mi) and several smaller tributaries, travel through Appomattox Court House NHP. The park lies in the headwater region of the Appomattox River Watershed (total drainage area 1,344 mi²), part of the larger James River Watershed, and ultimately draining into the Chesapeake Bay. The area of land that drains into the park is approximately 5.79 mi².

As a member of the Chesapeake Bay Program (CBP), the National Park Service has committed to management of the Chesapeake Bay watershed as a cohesive ecosystem. The National Park Service Chesapeake Bay

Riparian Forest Buffer Plan outlines the planning process for conservation of existing riparian forests and for restoration of streams and riparian forests within the Chesapeake Bay watershed. The four elements identified by the Federal Agencies Committee of the CBP that should be addressed by Federal agencies as part of the federal riparian forest buffer plan are as follows:

1. *“Federal land managers will assess current management activities and opportunities and propose specific strategies and quantitative goals for riparian forest protection and buffer restoration for those lands.”*
2. *“Federal land managers will ensure that all land uses, such as agricultural or commercial leases on public lands, will implement practices that promote, protect, and where feasible, restore riparian forest buffers and stream corridors.”*
3. *“Federal land managers will provide opportunities on federal lands for the establishment of demonstration and research sites for riparian forest buffer and stream corridor management.”*
4. *“Federal agencies will support, through technical assistance efforts; enhanced training and outreach in cooperation with state and local governments, to increase stream corridor and forest buffer management and restoration.”*

Currently, Appomattox Court House NHP is in violation of this agreement by allowing cattle direct access to wetlands and natural waters. None of the tributaries to the Appomattox River north of Route 24 within the park are fenced and it is unknown what effect grazing and agricultural activities are having on water quality.

A single spring located near Lee’s Headquarters was within the Confederate encampment area and likely served as a water source for Lee and his men. Several other springs reportedly occur within park boundaries but their locations are currently unknown/unmapped.

An inventory and analysis of existing baseline water quality data conducted by the NPS in 1998 revealed the almost complete absence of baseline information. In 2000, the NPS in cooperation with the U.S. Geological Survey conducted a level 1 water quality inventory and inventory results are currently pending. Approximately 84 acres of wetland area within the park are associated with the Appomattox River and its tributaries. The National Wetlands Inventory indicates that between 1982 and 1992, 42% of wetland areas within the Appomattox River Watershed were destroyed. The Environmental Protection Agency also describes the Appomattox River Watershed as having experienced a “high level” of wetland loss between 1982-1992 and cites population growth as the greatest pressure on the watershed. The EPA also states that the Appomattox River Watershed is vulnerable to loss of aquatic species, agricultural runoff, hydrologic modification, and air deposition. Allowing cattle direct access to natural water and riparian vegetation is a source of non-point pollution, recognized in the Clean Water Act as the major source of sediment, nutrient, and bacterial water pollution. The recently completed “Clean Water Action Plan: Restoring and Protecting America’s Waters” recognizes that while comprising a small percentage of the landscape, riparian areas are critical to water quality protection and the maintenance and health of streams and aquatic habitat.

The greatest threat to the preservation and protection of resources at Appomattox Court House NHP is an almost complete lack of baseline information on the status and condition of natural resources. Management decisions are made without an understanding of the condition of the park’s natural systems and how those systems are changing in response to threats. National Park Service legislation clearly directs the management and protection of all park resources, both natural and cultural. One of the park’s stated goals for management is “To acquire information – through surveys, research, or other means – necessary to facilitate protection, management, and interpretation of the park’s cultural and natural resources” (GMP 1977). The entire land base of Appomattox Court House NHP is considered a cultural zone (scenic easement, natural environment, and

development subzones) and thus natural resources are managed to support and complement cultural resources. However, wherever compatible with cultural resource objectives, guidelines for natural resources should be followed. Acquisition of baseline resource inventories and establishment of resource monitoring programs is essential to the preservation of natural resources at Appomattox Court House NHP.

Urbanization of adjacent lands and the surrounding community also threatens park resources. Route 460, a major 4 lane highway links Appomattox and Lynchburg and runs approximately 2 miles west of the park. Current long-range plans include the installation of public water and sewer lines along the highway that will ultimately lead to future development of the corridor and areas surrounding the park. Virginia Route 24 forms a high-speed 2-lane highway corridor through the park and divides it north/south. This highway is a major source of noise pollution, particularly in the historic village, and also is a source of air pollution, trash/litter, water pollution, and potentially hazardous materials should a spill/accident occur within park boundaries. Additionally, park visitors and park wildlife (particularly turtles) are at risk from speeding motorists. This threat is expected to continue and to increase over time as human population levels expand.

Non-native plant species represent a third threat to park resources. Invasive non-native/alien plants have biological characteristics that allow them to rapidly invade and out-compete native plant species for moisture, light, and nutrients. The park's GMP states that "vegetative growth in the fields ... is comprised of native varieties..." and additional NPS policy mandates for the management of alien plants are provided by the *Government Performance and Results Act of 1993* and *The Executive Order on Invasive Species* (February 1999). Kudzu (*Pueraria lobata*) is one species of great concern. This perennial vine can grow at a rate of a foot per day during the growing season, growing up and over existing vegetation and killing native vegetation through crowding and shading. Well established Kudzu populations can take up to ten years to eradicate (VA NHP Invasive Alien Plant List). Populations of Kudzu exist in areas surrounding the park, particularly along highways, but it has not yet been identified within park boundaries.

A *Strategic Plan for Managing Alien Invasive Vegetation* (Akerson and Heister 2000) was developed for and adopted by Appomattox Court House NHP in September 2000. The plan was developed by the Virginia Alien Vegetation Management Team in cooperation with park staff during summer 2000 after initially conducting a ground survey of park lands to determine the presence of alien vegetation. The plan identifies and describes 17 alien plant species, prioritizes them according to *the Handbook for Ranking Exotic Plants for Management and Control* (Hiebert and Stubbendieck 1993), identifies zones of caution and treatment area priorities, and describes control program implementation, NEPA compliance, and a system for monitoring program success. Currently, the estimated minimum acreage affected, at varying levels of infestation, is 550 acres (32% of total park acreage). Control efforts for tree-of-heaven (*Ailanthus altissima*) and princess tree (*Paulownia tomentosa*) began in September 2000.

As suggested previously, grazing and agricultural activities at Appomattox Court House NHP threaten the integrity of natural resources. Currently, the majority of leased land is maintained as pasture for cattle. Grazing operations currently allow for direct access of cattle to natural waters and to riparian vegetation. No scientific monitoring of vegetative or water resources has been conducted during the course of agricultural leasing activities in the park (since 1944). Soil samples have been taken and analyzed for nutrients approximately every 5 years. This information has been used to guide application of fertilizer and lime to pasture and hay fields. In addition to threats to natural resources, grazing activities pose a potential threat to park visitors and cultural resources. An unknown amount of old barbed wire fence from previous grazing activities still exists

attached to trees throughout park woodlots and in some cases visitors may access pastures by simply crossing a cattle guard. The presence of bulls during breeding season and heifers with calves in winter may pose a potential threat to visitors entering pastures at these times. Additionally, some pastures have within them historic structures or potentially important archeological sites. Cattle may damage buildings by rubbing up against them and standing near them for shade/protection and destroy archeological sites by compacting or otherwise disturbing the soil. It is essential that the Historic Leasing Program at Appomattox Court House NHP be evaluated and a Field Management Plan developed that not only meets the objective of perpetuating the historic scene but also provides for protection of natural and cultural resources.

Other threats to the integrity of natural resources which will not be discussed include forest pests such as gypsy moth and southern pine beetle, illegal activities such as poaching, and external threats such as logging operations, agricultural run-off, etc.

Management Issues:

Major Threats to Natural Resources

- Highway 24 – speed limit 55, threat of spills, corridor for spread of exotics, impacts to water quality/runoff
- Cattle grazing – water quality, spread of exotics, loss of biodiversity, soil compaction, sediment deposition in waterways, visitor safety, etc.
- Lack of baseline data on natural resources – water, air, vegetation, wildlife, etc.
- Presence of barbed wire fencing throughout wooded areas
- Presence of exotic plant species – tree of heaven, royal paulownia, kudzu (potential), johnson grass, stilt grass, oriental bittersweet, honeysuckle, etc.
- Use of adjacent lands – agricultural (application of herbicides/pesticides), streambank collapse/sediment due to grazing, logging by timber companies, etc.
- Poaching of wildlife/ running dogs through park – lack of law enforcement.

Petersburg National Battlefield (PETE)

Petersburg, VA

Visitation 148,676

Petersburg National Battlefield consists of 3140 acres in 10 separate units scattered over two counties and the cities of Petersburg and Hopewell. These 10 units include 2 isolated monuments and a national cemetery. Of these 3140 acres approximately 70% is forested with the predominate species being Loblolly Pine, Oaks, Sweet Gum and Poplar. Thick understory exists in many areas due to past logging operations and natural reforestation. The remaining acreage is open fields and developed areas. Much of the open field areas are managed under Agricultural permits for hay. Six small streams are found in the park and two small ponds (less than 1-acre ea.). A White-tailed deer population thrives in the main unit along with smaller mammals such as raccoons, fox, squirrels, skunk, opossum. Several types of snakes have been identified including the

Copperhead. Cottonmouth has unofficially been found along the banks of the James River at the City Point Unit. Bird life is plentiful with many migratory and nesting species present. Wild Turkey is making a comeback with common observations while Bald Eagles are occasionally seen flying overhead at the City Point.

Management Issues:

- Development of Adjacent lands
- Invasive Exotic Species
- Water pollution
- Funding/Staffing

Fredericksburg and Spotsylvania NMP (FRSP)

Fredericksburg, VA

Visitation 480, 820

Fredericksburg and Spotsylvania National Military Park has nine principal units spread out over 100 square miles of Virginia countryside. It covers approximately 6,789 acres. Located in the fastest growing area of Virginia, the once agricultural setting surrounding the park is being converted to a combination of subdivisions and strip malls. The park is rapidly becoming the only open space in the area. The park has an active farm program that currently manages over 900 acres of park historic scene. Another 1,000 or more open acres are managed by park maintenance staff. Crisscrossed by numerous streams, and containing substantial wetlands and a diverse wildlife population, the park is rapidly becoming the only open space in the community. Park wetlands have been mapped and there have been some preliminary inventories of RTE species, but very little baseline information exists on the park's biotic communities.

Management Issues:

- Exotic Species
- Deer
- Issues around farming – sedimentation, water quality, livestock lowering of open field plant diversity
- Mosquitoes
- RTE's
- Baseline inventory of all species
- Recreating historic landscape (removing trees and returning open fields into woodlands)

Shenandoah NP (SHEN)

Luray, VA

Visitation 1,339,286

Shenandoah National Park in the northern Blue Ridge Mountains of Virginia is the largest protected area in the mid-Atlantic region (79,380 ha [196,000 acre]) and the site of the scenic Skyline Drive. The elevation in the park is 192-1231 m (530-4050 ft) above sea level. Sixty peaks exceed a height of 915 m (3000 ft). Because of its vicinity to Washington, D.C. and other large eastern metropolitan areas, the park is a popular tourist destination.

The park has a diverse flora of northern and southern plants whose showy display of blooms in the spring and brilliant fall colors are renown nationwide. Many neotropical birds migrate through the park or nest there, and the large mixed mesophytic forest provides important habitat for many species of wildlife. The federally listed endangered Shenandoah salamander is endemic to the park.

High ozone levels and sulfate deposition; invasions by nonnative forest insects, diseases and plants; and destruction of habitats from development on adjacent lands threaten the natural resources in the park. Protection of the resources is challenging because of the long, narrow shape of the park.

In response to legal mandates and recognized threats, Shenandoah National Park began long-term ecological monitoring of water quality, air quality, brook trout and bears in the 1980s. In 1992, prototype ecological monitoring for the deciduous forest biome was continued through the I&M Program and is fully integrated into the resource management program of the Park. Since 1992, monitoring has been expanded to include rare plants, forest health, aquatic insects, other fishes, and neotropical birds. NPS natural-resource funding has been critical for the establishment of the I&M Program at Shenandoah, however, additional studies and funding by cooperating agencies such as the U.S. Geological Survey, U.S. Forest Service, U.S. Fish and Wildlife Service, state agencies, universities, and others play an important part in understanding and protecting park resources.

Gettysburg NMP (GETT)

Gettysburg, PA

Visitation 1,641,838

Located 50 miles northwest of Baltimore, the small town of Gettysburg, Pennsylvania was the site of the largest Civil War battle ever waged in the Western Hemisphere. The Battle of Gettysburg opened on July 1, 1863 and closed two days later with the climactic "Pickett's Charge". It resulted in a Union victory for the Army of the Potomac and successfully turned back the second invasion of the North by General Robert E. Lee's Army of Northern Virginia. Over 51,000 soldiers were killed, wounded or captured making it the bloodiest battle of the Civil War.

Gettysburg is primarily agricultural land, but there is approximately 37% is forested and the rest developed lands. There are ten ponds in the park with numerous small wetlands, and three drainages.

Eisenhower NHS (EISE)

Gettysburg, PA

Visitation 73,347

Eisenhower National Historic Site is the presidential and retirement home of Dwight D. Eisenhower. Purchased by Eisenhower in 1950, the 189 acre farm sported a show herd of Angus cattle and served as a presidential retreat, temporary White House, and meeting place for world leaders. Located adjacent to the Gettysburg Battlefield, the site today comprises 690 acres and is still maintained as a working farm.

Hopewell Furnace NHS (HOFU)

Elverson, PA

Visitation 74,303

Hopewell Furnace NHS is nestled in the rolling foothills of southeastern Pennsylvania. The entire park is drained by French Creek, a tributary of the Schuylkill River. Elevation ranges from just over 920 feet in the north to 460 feet at the low point where French Creek exits the park to the east. About three-fourths of the land (635 acres) is covered with secondary deciduous forest and other disturbed forest growth. Important tree species include oak (white, scarlet, red, and black), black birch, black gum, tulip tree, red maple, sweet birch, flowering dogwood, black cherry, white ash, and beech.

In a 1987 vegetation study, 504 species of vascular plants were identified in the park. Intrusive alien species can be found throughout the park.

French Creek and its main tributaries, Spout Run and Baptism Creek, are major components of the resource base of the park. Additional water resources include wetlands, numerous springs, floodplains, and an extensive groundwater system. Two wells in the park provide all drinking water for staff, residents, and visitors. French Creek flows through the heart of Hopewell Furnace NHS. It was designated as a Scenic River by the State of Pennsylvania in 1982 because of its outstanding natural and scenic values.

Adjacent to and within Hopewell Furnace NHS or partially within French Creek State Park are three Pennsylvania Natural Diversity Sites. These areas are identified by Berks County as having statewide significance for the protection of biological diversity. Of these, Pine Swamp, is one of only three sites in the county ranked as having the highest priority for protection. It is the largest wetland in Berks County but only a small part of it is protected as Pine Swamp Preserve within nearby French Creek State Park. Sixpenny Creek and French Creek are ranked as having high local significance in Berks County. Both are High Quality Cold Water Fisheries earning County recommendations for limited development in the watersheds and maintenance of vegetated buffers along the banks. These areas are particularly important for their value as natural buffers and proximity to Hopewell Furnace NHS.

Valley Forge NHP (VAFO)

Valley Forge, PA

Visitation 1,308,986

The Valley Forge National Historical Park is a vital part of America's national system of parks, monuments, battlefields, recreation areas, and other natural and cultural resources. Established by an Act of Congress in 1976, Valley Forge National Historical Park is located in Valley Forge, Pennsylvania. Containing approximately 3,500, the park preserves cultural and natural resources associated with the winter encampment of General George Washington and the Continental Army, in perpetuity and makes this valuable part of America's heritage available to over 2 million visitors each year for their experience, enjoyment, understanding, and appreciation.

Established as the first Pennsylvania State park in 1893, Valley Forge State Park was identified as having National significance and offered by the state for inclusion in the National Park Service. In the process leading to the establishment of Valley Forge National Historical Park, Congress provided conceptual basis to guide planning for the park's management and use. All forested communities in the park are permitted to develop under natural forces and without direct management intervention. There is a concern that aggressive alien plants and white-tailed deer are influencing the density and composition of native herbaceous, shrub and tree components of the park woodlots. There is concern that both of these are changing the forest communities to the extent that the visitor experience will be effected.

Appalachian National Scenic Trail (APPA)

14 states (PA, NH, VT, CT, NC, VA, TN, WV, ME, MA, GA, NY, NJ, MD)

The Appalachian Trail is approximately 2,150 miles long, with 543 miles running through the state of Virginia. All together the Trail passes through 14 states, 6 National Park Service areas, 7 National Forests and many state parks and forests. In total, it passes through more than 75 jurisdictions. As originally envisioned by forester Benton MacKaye in 1921, the AT connects the scenic high ridges of the Eastern Seaboard in one continuous public footpath from Springer Mountain, Georgia, to Mount Katahdin, Maine. Work on the trail commenced in 1922 and was completed in 1937.

In 1968 the AT became one of the original trails included under the National Trails System Act. Unlike most of the other 19 national scenic and historic trails, considerable lands has been purchased to protect the AT corridor. Since 1978, the NPS has purchase approximately 105,000 acres to protect the AT. This land is in addition to the 165,000 acres of the AT corridor that were present in 1978, most of it in existing national and state parks and forests. The trail corridor is generally 1,000 feet in width, though in some locations it extends over one mile in width. Currently, about 99% of the trail corridor is public land, and the remaining 1% is to be purchased by 2000.

The southern and central Appalachians are among the most biologically diverse areas within the United States. On maps produced by the World Wildlife Fund (1997), the Appalachian-Blue Ridge eco-region, which includes the southern and central Appalachians, is in the second highest ecoregion (out of 10) in the number of vascular plant and animal (mostly vertebrate) species found within the continental US. With regard to species endemism, the Appalachian-Blue Ridge ecoregion is also in the second highest category (out of 11) in number of species. The AT corridor protects many of these rare, threatened, and endangered plant and animal species and natural communities found only in higher elevations of the eastern US.

State by state inventories of rare, threatened and endangered species (RTE species) began in the early 1990's, with each state Natural Heritage Program conducting the inventory for their state. The first statewide inventory was conducted in Pennsylvania in 1990, with other states following. As of 1999, 429 natural heritage sites, containing 1,676 occurrences of RTE species or exemplary natural communities had been identified. In Virginia alone, 74 sites were surveyed finding 321 occurrences of RTE species.

Current Management Issues Include:

- More than 2000 occurrences of RT&E species and communities documented at more than 500 sites
- More than 100 RT&E species monitored by APPA Trail volunteers
- Cooperative management by the NPS, the USFWS, state parks and forest, the APPA Conference, and 32 APPA clubs, with the APPA Park Office holding overall responsibility.

Because the APPA crosses 3 regions it is "assigned" to the Washington Office rather than one particular region. It was not recognized as an I&M park until 2000 at which time it became assigned for inventory purposes to the Mid-Atlantic Network. Although part of this Network, The APPA has been independently allocated \$200,000 of I&M funds to conduct vertebrate and vascular plant inventories, its assignment to a Network was for inventory planning purposes only.

SECTION III-GATHERING EXISTING INFORMATION

Beginning in 1999 all existing information on vertebrates and vascular plants occurring in the Mid-Atlantic Network parks began to be compiled. Information in the form of species checklists, research, technical reports, management plans, wildlife observation cards, collecting permits, and both museum and university voucher specimens was gathered and entered into the NPSpecies and NRBib databases. Since 1999 this process has continued. Currently the Northeast Region's scientific librarian, hired to gather all bibliographic information for parks in the Northeast, is visiting each park individually to search their libraries and work with park staff in compiling information and update the NRBib database. Research Associates from Penn State University as well as private contractors continue to work on the NPSpecies database by adding new records of species occurrences and voucher specimens. The data mining process and database update, is and will be an ongoing process for a number of years for the Network.

3.1 NPSpecies

In the fall of 1999, resource managers in all nine of the Mid-Atlantic Network parks were asked to gather as many documents and electronic data sets as they could containing information on vertebrate and vascular plant species collected in their parks. These documents and electronic files were then sent out to the Natural Resource Information Division of the Inventory and Monitoring Program in Colorado for data entry and conversion to the NPSpecies database.

When the first version of NPSpecies was sent back to the Network in 2000, it was clear that some of the larger electronic databases had not converted well into NPSpecies. One of these being the regional NPS NPFlora and Fauna database maintained by Dr. John Karish at Penn State University. Unlike other NPFlora and Fauna databases that had been populated and then left untouched for years, this database was maintained and updated with references, vouchers and new species information. Over the years, research associates from Penn State University gathered and verified a large amount of vertebrate and vascular plant information for parks in the Network and entered it into this database. When the Network received its version of NPSpecies, containing this regional NPFlora and Fauna database, references associated with each record had been lost in the conversion, leaving species records either incorrectly documented or with no documentation at all.

This database was re-submitted to the I&M Program office to be re-converted in the fall of 2000. Once again in December 2000, each Network was asked to submit their updated and verified NPSpecies databases to the I&M Program office, this time to be incorporated into the web-based version of NPSpecies. At that time, the Mid-Atlantic Network had recently received the re-converted version of its NPSpecies database, containing the re-converted NPFlora and Fauna and SHEN databases. This did not allow time to verify all records before it was converted to the web version, so work on the database began again in February on the web-based version once it was released. Currently, experts and other qualified people are being hired to review and update portions of the NPSpecies database for the Network parks.

Ongoing Work

Penn State Research Associate

Beginning in May 2001 and funded through FY2002, a research associate (RA) at Penn State University, hired to clean up and continue work on the database, has been verifying each NPSpecies record with the records in the original NPFlora and Fauna database to assure that the conversion was complete and correct. This RA will continue to extract information from the databases and hardcopy documents originally sent by the Network parks to the I&M Program office in 1999. Detailed information from these sources such as abundance, habitat associations, nativity, etc... was not entered in the first effort to populate the database and all of this information still needs to be entered. This RA is also acting as the Network's NPSpecies "specialist" in answering any questions about the database for park staff as well as making sure that as the database is updated that this information is available to the parks. The RA is also responsible for coordinating the effort by experts and park staff in updating and maintaining the database. As the main contact for the Network, the RA keeps track of when and who is working on what sections of the database, so there is no duplication of effort, and when converted to the web-based version no new or existing data is lost. This person works cooperatively with the URI RA for the other Northeastern Networks.

SHEN Data Management

Currently about 95% of the SHEN I&M data has been converted from historical sources and placed into individual MS Access databases with consistent design and naming schemes. Customized "Front-end Applications" are being developed to meet the needs of each program individually, with data entry, summary reports, and data checking. A consistent "look and feel" is being applied to this conversion to facilitate planned integration of related program elements. Related spatial data is reviewed in consultation with the park-wide GIS specialist to confirm compatibility and to plan for eventual linkages. This processes has been carried out by the current SHEN I&M data manager, Alan Williams, in close consultation with the program managers.

In April 1999 the data manager position was vacated and the position remained vacant until 2000 when SHEN I&M entered into a cooperative agreement with the Conservation Management Institute (CMI), at Virginia Polytechnic Institute and State University to provide data management services. CMI staff started converting the monitoring data and developing program interfaces in MS Access. In July 2000 Alan Williams was hired through this cooperative agreement to work as the SHEN I&M data manager in the park. He is currently converting the I&M data, developing the program applications as well as other data management and computer support needs of the SHEN I&M program.

Historically data have been managed individually by program managers with assistance provided by a data manager. This has lead to inconsistencies that can make meta-analyses and long term management difficult. The current goal is to pull the individual program data together into an integrated database to take full advantage of the relational database design. Individual program "Applications" will continue to provide program users the means to enter and summarize program specific data. The centralized database with its established relationships will be available to program managers to explore and utilize for cross-discipline summaries and GIS applications.

SHEN Data Management Accomplishments

- 1) Database systems development, modification, and maintenance for long-term archiving and retrieval of data sets produced by the I&M program and supporting cooperators.
 - a) Wildlife
 - Bear Bait Station Survey Database Application Constructed and populated with historical data plus 2000 and 2001 data .
 - Fish Monitoring Database Cleaned up database structure and updated the user interface
 - Amphibians –conversion and update of many years of field observations.
 - Aquatic Macro-invertebrates –Database structure cleaned up and the user interface updated. Development of an application for cooperators to enter data ensuring a minimum level of data quality and facilitating incorporation into the master data set.
 - Birds –MAPS data summarized from cooperators database to provide basic statistics for resource managers.
 - NPSpecies – Data check and collated.
 - b) Botany
 - Deer Exclosure Vegetation Monitoring database and user interface created.
 - TLTEMS database structure cleaned up and the user interface updated. Developed some summaries of the long term data.
 - Data loggers configured to help staff collect data directly into handheld field computers and then incorporate that data into project databases.
 - Big Meadows Shrub Monitoring database and user interface created.
 - NPSpecies – Helped data check and collate data for this NPS data product.
 - Rare Plants –Data conversion from various sources into a database with a user interface.
 - Vista Management – Data conversion from various sources into a database with a user interface.
 - Deer Exclosure Vegetation Monitoring database, with summaries and user interface created.
 - c) Abiotic
 - Water Chemistry – Beginning to clean up and consolidate data collected from different efforts into a centralized database.
 - d) Cultural
 - Historical Land Tracts – Beginning to clean up and consolidate data collected from different efforts into a centralized database with user interface.
 - ASMIS – Set-up and problem-solving of existing system.
- 2) Ensure complete documentation (Metadata) of all data sets.
 - Documentation of new databases has been going on internally. Entries into the Dataset catalog has just begun.
- 3) Work with all NPS cooperators to incorporate data into the system.
 - NPSPP Amphibian researchers
 - VATech Macro Invert researchers
- 4) Protocols established for the documentation and transfer of data.

3.2 NRBIB Database

In 1996-1997 parks in the Mid-Atlantic Network were visited to initially gather existing bibliographic information to create the Network NRBIB database. Since then, little or no updating of this database has taken place. In April 2001 the process to update the original database began. The Northeast Region's scientific librarian has been visiting each park in order to interview staff and to locate additional sources of information. Simply searching staff bookshelves and filing cabinets has resulted in new references to be added to the database. Because the database has not been regularly updated since 1997, it has required some initial editing and revision, specifically, checking for duplicate records, missing bibliographic information, and/or incorrect bibliographic information before new records are added. Once this is complete, the databases will then be updated with the addition of new records. Existing records will be updated if necessary with new storage locations when applicable and/or more detailed bibliographic information if needed. Part of the database update will include searching local and state government resources and repositories such as Natural Resource Commissions, Utility Commissions, Land Management Offices. Local and regional libraries such as public, college, university, and state libraries will also be searched as well as private and public agencies such as bird clubs, trail clubs, adjacent land owners or facilities and finally CD-ROM, online and Internet resources will also be searched.

APPA NRBib

The National Park Service entered into a cooperative agreement with Penn State University to complete a comprehensive Natural Resource Bibliography for the Appalachian National Scenic Trail. This project will begin in December 2001 and take approximately eight months to complete. The work is due to be completed by September 30, 2002. The APPA has not yet had any NRBib developed.

3.3 Dataset Catalog

The Network entered into a cooperative agreement (FY2000) with North Carolina State University (NC State) to complete FDGC metadata for all existing spatial data sets from the Network parks. All parks with GIS capabilities were visited by NC State staff and FDGC metadata was written on data sets during those park visits. All other Network spatial data information was compiled at NC State. The University has also been data mining for other spatial data sets existing outside of the parks and writing metadata for those as well. NC State staff are currently in the process of transferring the FDGC metadata they have created for the Network to the revised version of the Dataset Catalog released, May, 2001, this will be completed by October, 2001. Information will be entered concerning geospatial data sets as well.

3.4 Voucher Specimen Data Mining

In order to provide verifiable and legal documentation of a species occurrence within the Network parks, natural history museums and other institutions were searched in 1999-2000 for records of vertebrate and vascular specimens collected within park boundaries. The search included contacting one hundred and eight institutions (Table 2). All Investigator's Annual Reports (IAR) and collection permit contact information were reviewed in order to identify potential collections containing NPS specimens. An initial contact letter was mailed out to the sources identified requesting catalog number and specific locality information on specimens that were collected from the Network parks. Institutions were given a preliminary deadline of one month to receive records, however, since this deadline was rarely met, a second letter verifying receipt of the initial letter and offering

further assistance was mailed out at that time. Additional contacts were made for delinquent institutions on a monthly basis until a response was received. Most larger institutions (e.g. Carnegie Museum of Natural History) requested monetary compensation for querying their databases. The decision to provide monetary compensation was made based on the likelihood of the institution providing a sizable amount of relevant data for the Network.

Records that were received from most, if not all, institutions were not specific to a given park. In order to verify whether or not a specimen was collected from within a park, the data was sorted by park based on state counties. This information was then mailed to each resource manager for further verification. As with the initial institutional contact letters each park was requested to return the verified records within one month upon receipt and re-contacted if the data was not returned.

Fish Voucher Search

Dr. Jay Stauffer and Research Associate, Timothy Stecko from Penn State University are conducting a fish voucher search for Northeast region parks in PA, MD, VA, NY, and WV. All of the Mid-Atlantic Network parks are included in this search. The project entails putting together species lists, gathering distribution maps, and catalog information of fishes collected in and adjacent to national parks in these three states. Parks are being contacted for information regarding scientific collections permitting within the park. If fish collections are known to have occurred within the park the collector(s) are being contacted and the fish data obtained. Collections made near each park can also provide important information about fish distributed within, therefore each state's fish management agency is being contacted as well to determine other fish data sources. A list is being developed of all entities known to have conducted fish surveys within each state. All data collected during this project is being entered into the NPSpecies database as well as a relational database that will eventually be linked to the GIS Theme Manager.

Table 2. Institutions contacted for voucher data collected in the Eastern Rivers and Mountains Network.

1. Academy of Natural Science	2. Rhode Island c/o FIIS	3. Normandeau Associates, Inc.
4. Agricultural Research Service	5. Fire Island National Seashore	6. NC State Museum of Natural Sciences
7. Allegheny Portage Railroad National Historical Site	8. Florida Museum of Natural History	9. North Carolina State University
10. Allbright College	11. Fort Necessity National Battlefield	12. North VA Community College
13. American Museum of Natural History	14. Friendship Hill National Historic Site	15. Old Dominion University
16. Appomattox Court House National Historical Park	17. Fredericksburg & Spotsylvania NMP	18. PA Bureau of Plant Industry
19. Assateague Island National Seashore	20. GAI Consults, Inc. for Columbia Gas Corp	21. PA Dept. of Agriculture
22. Bluestone National Scenic River	23. George Mason University	24. PA Fish and Boat Commission
25. Gauley River National Recreation Area	26. Gettysburg Area High School	27. PA State Museum at Harrisburg
28. New River Gorge National River	29. Gettysburg College	30. Pennsylvania State University
31. Booker T. Washington Nat'l Monument	32. Hampden-Sydney College	33. Petersburg National Battlefield
34. Canada Museum of Nature	35. Harvard University	36. Ramapo College
37. Columbia University	38. Hopewell Furnace National Historical Site	39. Randolph Macon College
40. Brooklyn Botanic Garden	41. Johns Hopkins University	42. Richmond National Battlefield
43. Carnegie Museum of Natural History	44. Kent University	45. Rutgers University
46. Univ. of MD Center for Environmental Sciences	47. Indiana University of Pennsylvania	48. Rutgers, the State University
49. Cleveland Museum of Natural History	50. Lord Fairfax Community College	51. Salem Teikyo University
52. The College of William and Mary	53. Marshall University	54. Seneca Valley High School
55. Colonial National Historical Park	56. Maryland Dept. of Natural Resources	57. Shenandoah National Park
58. Cornell University	59. Mercer Museum	60. Shippensburg University
61. Delaware Museum of Natural History	62. Michigan technical University	63. U.S. Dept. of Agriculture
64. Delaware Water Gap National Recreation Area	65. Missouri Botanical Gardens	66. U.S. Regional Pasture Research Lab
67. Drew University	68. Montclair State University	69. University of California
70. Drexel University	71. Natural History Museum of LA County	72. University of Delaware
73. Duke University	74. Natural History Society of MD	75. University of Illinois
76. East Stroudsburg University	77. The Nature Conservancy	78. University of Kansas
79. Elizabethtown College	80. New Jersey DEP	81. University of Maryland
82. EPA	83. NJ Fish, Game, and Wildlife	84. University of Massachusetts
85. Farimont State College	86. NJ Heritage Program	87. University of Michigan
88. Ferrum College	89. NJ State Museum	90. University of Minnesota
91. University of Wisconsin	92. NY Botanical Garden	93. University of North Carolina
94. Upper Delaware Scenic and Recreation River	95. University of NC at Chapel Hill	96. Virginia Museum of Natural History
97. Valley Forge National Historical Park	98. University of PA, Morris Arboretum	99. University of Richmond
100. Virginia Polytech	101. West Chester University	102. West Virginia University
103. VA Commonwealth University	104. West Virginia Department of Agriculture	105. The Field Museum
106. VA Dept. of Cons. and Rec. Div. Of Nat. Heritage	107. West Virginia Natural Heritage Program	108. NY State Museum at Albany

SECTION IV-DETERMINING INVENTORY NEED

SHEN

As a representative of the deciduous forest biome, SHEN was chosen by the I&M Program as a prototype monitoring park in 1992. Fully integrated into the resource management of the park, SHEN began its program by monitoring water quality, air quality, brook trout and bear, and have since expanded the program to include rare plants, forest health, aquatic insects, other fish, and neotropical birds. When asked about inventory needs, the staff at Shenandoah decided that because they had much of their baseline inventories complete for vertebrates and vascular plants, that they would rather see their share of Network inventory funds be used towards completing baseline inventories in those parks that have little or not data. SHEN staff attended the VA scoping workshop in April 2001, and were key in helping to identify inventory needs for the other Network parks.

APPA

Determining the biological inventory needs for the trail is a huge task. The Trail covers approximately 270,000 acres, 108,000 of that in NPS fee ownership. The 108,000 acres does not include the many acres of NPS lands in parks that APPA travels through including DEWA, HAFE, CHOH, SHEN, BLRI and GRSM. The AT travels 2,167 miles through 3 NPS Regions, 6 Networks and across 14 states in the East (Maine to Georgia). It crosses most of the highest elevations and a number of rare habitats in the East as it hugs the ridges and crosses the valleys. In order to determine and prioritize inventory gaps, all existing projects and data need to be compiled. Subject matter and taxonomic experts can review data compilations and determine where the greatest and most important data gaps exist. We learned that significant habitat for the listed Shenandoah salamander exists along the trail *outside* of Shenandoah. Currently there are no records of the salamander there since these areas were not searched as the SHEN area was studied. The Network strategy will blur some of these political boundaries for biological inventories in the future.

APPA lacks many of the 12 basic data sets for I&M parks such as base cartography, a natural resource bibliography, level I water quality, geology, soils, etc. As part of the I&M Program, development of the first of the 12 datasets was funded in 2001, creating an NRBIB database for the park. In addition, acquisition of base cartography for the entire park has begun.

The Appalachian Trail is a newcomer to the I&M program. Since it is managed out of the Washington Office, it was not affiliated with any region and was not included in the initial list of I&M parks. It was added to the “official” list of I&M parks and placed in the Mid-Atlantic Network in FY 2001 for biological inventory purposes. Abby Miller, Associate Director for Science and Stewardship talked with APPA managers about the I&M program and how they fit into the program since the park does not have a Resource Management Plan and has not completed RMAP data. In order to determine inventory and monitoring priorities, APPA first needs to identify management issues and resources of concern through a Resource Management Planning-type process. The Northeast Region I&M Coordinator and science staff will work with park staff and cooperators to identify needed basic inventory data sets, resources of concern and management issues. An initial meeting was held in April 2001.

The inclusion of APPA in the Mid-Atlantic Network was a Washington Office decision, and since the Mid-Atlantic Network had already been given a funding ceiling for biological inventories of vertebrates and vascular plants that did not include APPA, the park has been given it’s own funding ceiling of \$200,000 to be distributed

over the next 4-5 years. This funding amount was determined by comparing RMAP values of other long and narrow parks such as the Blue Ridge Parkway.

Approximately \$272,000 of private funding was used to contract with State Natural Heritage Programs to conduct RTE surveys (mostly plants) along the trail over the last ten years. The RT&E surveys began in 1990 and are just being completed this year (2001). Two thousand and thirty-eight occurrences of RTE species were identified. A Rare and Exemplary Natural Communities Survey identified over 100 globally rare communities. Very little of this data is in digital format; they exist in hard copy reports.

Exotic species are a suspected threat to the exemplary natural communities along the AT. Small areas in Virginia have been evaluated for exotic species. An inventory of exotics threatening natural heritage sites has been recommended.

Although this is a document for determining inventories, it is also worth documenting discussions of a strategy for vital signs monitoring of APPA here. The trail travels through 6 networks in the East. As part of the discussion with Abby Miller, vital signs monitoring was considered for the park, although there was no mention of additional funding to be provided. Each network that the trail passes through will decide on the best place to monitor vital signs, including the best locations along it. It may be that no vital signs monitoring takes place on the trail within a certain network, but the park will benefit by having network expertise at its disposal for local resource management questions/issues. The vital signs program is looking at developing a strategy to answer big questions. Therefore, it makes sense that each network APPA passes through should invite park staff to participate in the vital signs monitoring program development process. In addition, APPA began working on a monitoring strategy with their cooperators in 2001, a process that the I&M program will follow in the future.

BOWA, RICH, PETE, APCO, FRSP, VAFO, GETT, EISE, HOFU

For the nine other Mid-Atlantic Network parks, species lists from NPSpecies could not be used with confidence to determine the completeness of inventories in these parks. The completeness and correctness of the Network's NPSpecies database is currently being verified as part of the database work described in Section 3.1 and therefore has not been used as a means for determining inventory needs. In some cases such as the PA parks in the Network, data from current inventory projects has not yet been entered into NPSpecies. Because of this lack of accurate or verified species data, calculating the percentage of species found in the parks was not possible. The next most logical step in best determining inventory gaps was to compile and review a variety of existing information. The following steps were taken by the Network to help best determine inventory need:

1. Review the existing references for each park by taxa.
2. Hold Scoping Workshops and invite local experts familiar with or doing research in the parks that could assist in identifying inventory gaps.
3. Review and compile descriptions of inventories in progress in the parks.

4.1 Review of Existing References

The regional I&M Program librarian searched the Network NRBib database by park and by taxa, creating individual bibliographies for each. These references were then reviewed by Regional I&M staff, park staff and taxa experts attending the scoping workshops. The most recent references of inventory work (within the last ten years) were compiled and a table created with the most up to date work. In some cases, the most complete work was older than ten years and those were added to the tables as well (Tables 3a-e). Park resource managers

provided information on inventory work taking place in the parks, and this was added to the tables as well. All hardcopy documents sent to WASO for the initial population of NPSpecies were sent back to the Regional I&M office and these documents themselves were reviewed for completeness and scientific validity. Simply compiling all of this information and putting it in an easily readable format helped the parks begin to identify their inventory gaps.

Table 3a-e. Vertebrates and vascular plants references for parks in the Mid-Atlantic Network.

APCO	
BIRDS	▪ No recent references found
MAMMALS	▪ No recent references found
FISH	▪ No recent references found
HERPS	▪ No recent references found
PLANTS	<ul style="list-style-type: none"> ▪ Hamilton, S.C. 1985. Forest management plan for the Appomattox Court House National Historical Park, Virginia. Virginia Polytechnic Institute and State University, Department of Forestry. Masters Thesis. 160 pp. ▪ Lund, A. May 21, 1992. Survey and documentation of the vascular plant species of Appomattox Court House National Historical Park. Biology Department, Hampden-Sydney College, Hampden-Sydney, VA. Paper presented in the Botany Section of the Virginia Academy of Science, May, 21, 1992, at University of Richmond, Richmond, VA. 12 pp. (In NPSpecies) (Collected 327 species so far, including 52 new records for the county-Has Herbarium) ▪ Nancy Cowden, Lynchburg College, 2001-working on a species list for newly acquired land.
T&E SPECIES	▪ Virginia Department of Conservation and Recreation, Natural Heritage Division. 1991. A natural heritage inventory of Mid-Atlantic Region National Parks in Virginia: February 1991 progress report. Virginia DCR, NHD, Richmond, VA. 29 pp.

Table 3b.

BOWA	
BIRDS	▪ No author, no date. Birds seen at Booker T. Washington National Monument. 1 pp.
MAMMALS	▪ Rabenau, W. December 1985. Mammal survey of Booker T. Washington National Monument. U.S. Department of Interior, National Park Service, Booker T. Washington National Monument. Investigator's Annual Report. Hardy, Virginia. 8 pp. [Also known as Litton and Rabenau, 1985.] (In NPSpecies)
FISH	▪ No recent references found
HERPS	▪ No recent references found
PLANTS	<ul style="list-style-type: none"> ▪ Critz, R.W. 1986. Flora survey. U.S. Department of Interior, National Park Service, Booker T. Washington National Monument. Investigator's Annual Report. Hardy, Virginia. 7 pp. (In NPSpecies) ▪ Mengak, F.K. and M.T. Mengak. 1989. Floral survey of Booker T. Washington National Monument. U.S. Department of Interior, National Park Service, Booker T. Washington National Monument. Investigator's Annual Report. Hardy, Virginia. 3 pp. (In NPSpecies) (193 plants collected-deposited in Ferrum College) ▪ U.S. Forest Service. 1982. (Title unknown - subject is historically significant trees at Booker T. Washington National Monument.) ▪ Powers, Susan. 1999. Plant Survey-Booker T. Washington. (Ferrum College Student-currently a field Biologist for USDA Forest Service)(122 plants identified)
T&E SPECIES	▪ Virginia Department of Conservation and Recreation, Natural Heritage Division. 1990. A natural heritage inventory of Mid-Atlantic Region National Parks in Virginia: Natural Heritage Division. Report No. CA4000-8-8018.

Table 3c.

FRSP	
BIRDS	▪ No recent references found
MAMMALS	▪ No recent references found.
FISH	▪ No recent references found
HERPS	▪ No recent references found
PLANTS	<ul style="list-style-type: none"> ▪ Orwig, D.A. and M.D. Abrams. 1991. Woody vegetation and fuel survey for evaluating wildfire hazard in Spotsylvania County. Report to U.S. Dept. of Interior, National Park Service. University Park, PA. 109 pp. (In NPSpecies) ▪ Orwig, D.A. and M.D. Abrams. 1994. Land-use history (1720-1992), composition, and dynamics of oak-pine forests within the Piedmont and Coastal Plain of northern Virginia. Can. J. For. Res. 24: 1216-1225. (In NPSpecies) ▪ Orwig, D.A. 1995. Unpublished list of common and scientific names of woody species identified within Fredericksburg, Chancellorsville, and Wilderness Battlefields. 2pp. (In NPSpecies) ▪ Davis, D.D. and J.P. Bennett. 1985. Evaluation of air pollution injury to vegetation in four Mid-Atlantic National Park Service Areas. Report to the National Park Service. (In NPSpecies) ▪ Davis, D.D. 1988. A preliminary survey to determine the potential impact of air pollution on vegetation in Colonial National Historical Park and Fredericksburg-Spotsylvania National Military Park. Report to the National Park Service. 13 pp. (In NPSpecies)
T&E SPECIES	▪ Ludwig, J.C. and C.A. Pague. 1993. A natural heritage inventory of Mid-Atlantic National Parks in Virginia: Fredericksburg and Spotsylvania National Military Park. Final Report to the National Park Service. 87 pp. (In NPSpecies)

Table 3d.

PETE	
BIRDS	▪ No recent references found.
MAMMALS	▪ No recent references found.
FISH	▪ No recent references found.
HERPS	▪ No recent references found
PLANTS	<ul style="list-style-type: none"> ▪ Rosenzweig, M.S. and D.M. Porter. 1990. Flora of Petersburg National Battlefield. U.S. Dept. of Interior, National Park Service, Mid-Atlantic Region. 48 pp. (In NPSpecies) ▪ Davis, D.D. and J.P. Bennett. 1985. Evaluation of air pollution injury to vegetation in four Mid-Atlantic National Park Service Areas. Report to the National Park Service. (In NPSpecies) ▪ Rantis, P.A. and J.E. Johnson. April 1995. Forest management and the restoration of historic scenes. Petersburg National Battlefield Park, Virginia. Draft final report. 90 pp. (In NPSpecies)
T&E SPECIES	• Ludwig, J. Christopher and Christopher A. Pague, Feb. 1993, A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Petersburg National Battlefield.

Table 3e.

RICH	
BIRDS	<ul style="list-style-type: none"> No recent references found
MAMMALS	<ul style="list-style-type: none"> No recent references found
FISH	<ul style="list-style-type: none"> No recent references found
HERPS	<ul style="list-style-type: none"> No recent references found
PLANTS	<ul style="list-style-type: none"> Hayden, W.J., M.L. Haskins, and M.F. Johnson. January 1988. Flora of Richmond National Battlefield Park (Beaver Dam Creek, Malvern Hill, and Parker's Battery Units). U.S. Dept. of Interior, NPS, Mid-Atlantic Region. Research/Resources Management Report MAR-27. Philadelphia, Pennsylvania. 34 pp. (Also published in June 1989 in <i>Castanea</i> 54(2): 87-104.) (In NPSpecies) Hayden, W.J. and M.F. Johnson. January 1986. Flora of Richmond National Battlefield Park (Chickahominy Bluffs, Cold Harbor, Fort Darling, Fort Harrison, Garthright House, and Watt House Units). U.S. Dept. of Interior, NPS, Mid-Atlantic Region. Research/Resources Management Report MAR-16. Philadelphia, Pennsylvania. 40 pp. (In NPSpecies) Helm, A.C. and J.E. Johnson. July 1994. Forest vegetation and its management for aesthetics, recreation, and historical interpretation. U.S.D.I. NPS, Mid-Atlantic Region. 183 pp. (In NPSpecies)
T&E SPECIES	<ul style="list-style-type: none"> Ludwig, J.C. and C.A. Pague. February 1993. A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Richmond National Battlefield Park. Final Report to the Mid-Atlantic Regional Office, National Park Service. 15 pp. (In NPSpecies)

Table 3f.

HOFU	
BIRDS	<ul style="list-style-type: none"> In Progress-Yahner-Comprehensive Inventory Program for Birds at Six Pennsylvania National Parks: Phase II. 1999- 1999-Yahner et al. Inventorying and Monitoring Protocols of Terrestrial Vertebrates, HOFU
MAMMALS	<ul style="list-style-type: none"> 1999-Yahner et al. Inventorying and Monitoring Protocols of Terrestrial Vertebrates, HOFU 1997-Yahner et al. Inventorying and Monitoring Protocols: Mammals
FISH	<ul style="list-style-type: none"> In progress-PSU-Stauffer, Identification of Fish Data Sources
HERPS	<ul style="list-style-type: none"> In progress-West Chester U.-Tiebout-1999-2001 1999-Yahner et al. Inventorying and Monitoring Protocols of Terrestrial Vertebrates, HOFU
PLANTS	<ul style="list-style-type: none"> 1999, Russell and Bowersox, 504 species, Need exotics Russell and Schuyler. 1999, Bowersox and Larrick, Long-term veg monitoring of forested ecosystems at HOFU and VAFO. Vegetation and flora Vanderwerff, W. D. 1994. The Vascular Flora of HOFU

Table 3g.

VAFO	
BIRDS	<ul style="list-style-type: none"> ▪ In Progress-Yahner-Comprehensive Inventory Program for Birds at Six Pennsylvania National Parks: Phase II. 1999- ▪ 1999- Inventorying and Monitoring Protocols of Terrestrial Vertebrates, VAFO
MAMMALS	<ul style="list-style-type: none"> ▪ 1999- Inventorying and Monitoring Protocols of Terrestrial Vertebrates, VAFO ▪ 1997-Yahner et al. Inventorying and Monitoring Protocols: Mammals
FISH	<ul style="list-style-type: none"> ▪ In progress-PSU-Stauffer, Identification of Fish Data ▪ Complete by PSU Sources
HERPS	<ul style="list-style-type: none"> ▪ In progress-West Chester U.-Tiebout-1999-2001 ▪ 1999- Inventorying and Monitoring Protocols of Terrestrial Vertebrates, VAFO
PLANTS	<ul style="list-style-type: none"> ▪ 1999, Russell and Bowersox, 371 species, 12 state listed species, 10 targeted exotics are mapped. ▪ 1999, Bowersox and Larrick, Long-term veg monitoring of forested ecosystems at HOFU and VAFO. ▪ Holt, J.-1987. Plants of Valley Forge Park. ▪ Hulmes, D.-1990.Wildflowers of Valley Forge. ▪ Newbold, A. -1994. Report of Wetlands Vegetation Study. VAFO. ▪ Newbold, A. 1991-1994. Report on the Graminoids of the Tall Grass Meadows. VAFO

Table 3h.

EISE	
BIRDS	<ul style="list-style-type: none"> ▪ In Progress-Yahner-Comprehensive Inventory Program for Birds at Six Pennsylvania National Parks: Phase II. 1999-
MAMMALS	<ul style="list-style-type: none"> ▪ 1997-Yahner et al. Inventorying and Monitoring Protocols of Vertebrates: Mammals
FISH	<ul style="list-style-type: none"> ▪ In progress –PSU-Stauffer, Identification of Fish Data Sources
HERPS	<ul style="list-style-type: none"> ▪ 2001 Yahner et al. Inventory of Amphibian and Reptile Species at GETT and EISE.
PLANTS	<ul style="list-style-type: none"> ▪ 1997 Bowersox, T.W. et al.Regenerating Mixed-Oak Historic Woodlots at GETT and EISE. ▪ 1997-Storm, G.L. et al. Plant Community Development in Historic Forest Stands at GETT and EISE. ▪ 1991-Yahner, R. H., G. L. Storm, R. E. Melton, G. M. Vecellio, and D. F. Cottam. Floral inventory and vegetative cover type mapping of GETT and EISE.

Table 3i.

GETT	
BIRDS	<ul style="list-style-type: none"> ▪ In Progress-Yahner-Comprehensive Inventory Program for Birds at Six Pennsylvania National Parks: Phase II. 1999-
MAMMALS	<ul style="list-style-type: none"> ▪ 1997-Yahner et al. Inventorying and Monitoring Protocols of Vertebrates: Mammals
FISH	<ul style="list-style-type: none"> ▪ In progress –PSU-Stauffer, Identification of Fish Data Sources
HERPS	<ul style="list-style-type: none"> ▪ 2001 Yahner et al. Inventory of Amphibian and Reptile Species at GETT and EISE. ▪ 1989-Hulse, A. C. Survey of amphibians and reptiles of GETT
PLANTS	<ul style="list-style-type: none"> ▪ 1997 Bowersox, T.W. et al.Regenerating Mixed-Oak Historic Woodlots at GETT and EISE. ▪ 1997-Storm, G.L. et al. Plant Community Development in Historic Forest Stands at GETT and EISE. ▪ 1991-Yahner, R. H., G. L. Storm, R. E. Melton, G. M. Vecellio, and D. F. Cottam. Floral inventory and vegetative cover type mapping of GETT and EISE. ▪ 1986-Smith and. Mummert. A study of the woody flora of GETT. ▪ 299 species, 12 listed-Need exotics

Table 3j.

SHEN	
BIRDS	<ul style="list-style-type: none"> ▪ Evans, Gwynn. Summary of the Shenandoah National Park/ Luray Christmas Bird Census, 1969-1990. Knoxville, Tenn. ▪ Birds of Shenandoah National Park. 1994. Shenandoah Natural History Association. ▪ Birds of Shenandoah National Park. Revised 1987. Shenandoah Natural History Association. ▪ Wilhelm, Dr. E.J. Birds of Shenandoah National Park. June 1966. Shenandoah Natural History Association. ▪ Wetmore, Alexander. The List of Birds of Shenandoah National Park. Third Revision. 1950. Shenandoah Natural History Association. ▪ Lindsay, Terry and P. Lindsay. Birds of Shenandoah National Park, A Naturalist's View. 1997. Shenandoah Natural History Association. ▪ Simpson, Marcus B. Jr. Birds of the Blue Ridge Mountains. 1992. University of North Carolina Press.
MAMMALS	<ul style="list-style-type: none"> ▪ Manville, Richard H. The Mammals of Shenandoah National Park. 1956. Shenandoah Natural History Association. Bulletin No. 2.
FISH	<ul style="list-style-type: none"> ▪ Atkinson, J.B. Fisheries Data from Flood Impacted Streams at Shenandoah National Park. July 1995. ▪ Fish Species of Shenandoah National Park. 1985. No author listed ▪ Lennon, R.E. and P.S. Parker. A Summary of Fishery Investigations in Shenandoah National Park in 1957. February 1958. USFWS. ▪ Parker, Phillip. A Summary of Fishery Investigations in Shenandoah National Park in 1959. March 1960. ▪ Lennon, Robert and P.S. Parker. A Summary of Fishery Investigations in the Shenandoah National Park in 1956. February 1957. ▪ Lennon, Robert and P.S. Parker. A Summary of Fishery Investigations in Shenandoah National Park in 1955. January 1956. ▪ Fisheries Management and Data Report, Shenandoah National Park, 1994. March 1995.
HERPS	<ul style="list-style-type: none"> ▪ Reptiles and Amphibians, SNP. Constraints in Cooperative Product Development. Excerpts from published reports. ▪ Witt, L. William. Amphibians and Reptiles of Blue Ridge Parkway from Roanoke to Shenandoah National Park, a Checklist. Arlington, VA. 1972. ▪ Witt, William L. Annotated Checklist of the Amphibians and Reptiles of Shenandoah National Park, Virginia. 1993. Catesbeiana, Vol. 13(2), pp. 26-35. ▪ Mitchell, Joseph C. Checklist of the Amphibians and Reptiles of Shenandoah National Park. June 1988.

SHEN cont. PLANTS	<ul style="list-style-type: none"> ▪ Camp, W.H. 1936. On Appalachian trails. <i>Journal of the New York Botanical Garden</i> 37(443): 249-267. ▪ Fosberg, F.R. and E.H. Walker. 1941. A preliminary check list of plants in the Shenandoah National Park, Virginia. <i>Castanea</i> 6(6-7): 89-135. ▪ Fosberg, F.R. and E.H. Walker. 1943. First supplement to a preliminary check list of plants in the Shenandoah National Park. <i>Castanea</i> 8: 109-115. ▪ Fosberg, F.R. and E.H. Walker. 1948. Second supplement to a preliminary check list of plants in the Shenandoah National Park. <i>Castanea</i> 13(2): 83-92. ▪ Fosberg, F.R. and E.H. Walker. 1955. Third supplement to a preliminary check list of plants in the Shenandoah National Park. <i>Castanea</i> 20(2): 61-70. ▪ Fosberg, F.R. 1959. Notes on the Shenandoah National Park flora. <i>Castanea</i> 24: 135-143. ▪ Fosberg, F.R. 1965. Further notes on Shenandoah National Park plants. <i>Castanea</i> 30: 191-205. ▪ Mazzeo, P.M. 1966. New additions to the Shenandoah National Park Flora. <i>Castanea</i> 31: 236-240. ▪ Mazzeo, P.M. 1966. Notes on the conifers of the Shenandoah National Park. <i>Castanea</i> 31:240-247. ▪ Mazzeo, P.M. 1966. Exotic and native ornamentals in the Shenandoah National Park. <i>American Horticultural Magazine</i> 45(4): 419-421. ▪ Black, D.M. 1966. Scientific and common names of plants that have been seen or collected in Shenandoah National Park as of January, 1966. Unpublished report. ▪ Mazzeo, P.M. 1967. New additions and notes to the Shenandoah National Park Flora. <i>Castanea</i> 32: 177-183. ▪ Mazzeo, P.M. 1972. Further notes on the flora of the Shenandoah National Park, Virginia. <i>Castanea</i> 37: 168-178. ▪ Mazzeo, P.M. 1972. The gymnosperms of Virginia: a contribution towards a proposed state flora. <i>Castanea</i> 37: 179-195. ▪ Langdon, J.M. 1977. Checklist of plants of Shenandoah National Park. Unpublished report. ▪ Mazzeo, P.M. 1981. An illustrated guide to the ferns and fern allies of Shenandoah National Park, Virginia. The Shenandoah Natural History Association, Inc. Luray, Virginia. ▪ Langdon, K. and J. Langdon. 1981. Memorandum on the threatened and endangered plants of the central district. Unpublished report. ▪ Baxter, E.E. 1983. Vascular plants of a remnant swamp at Big Meadows, Shenandoah National Park. Unpublished report. ▪ Baxter, E.E. 1986. Vegetation and soil moisture survey of Big Meadows swamp, Shenandoah National Park. Unpublished report. ▪ Smith, J. 1986. Inventory of the plant specimens in the herbarium at Byrd visitor center in Shenandoah National Park . Unpublished report. ▪ Dawson, R.F. 1988. List of species collected and added to the herbarium in 1988. Unpublished report. ▪ Baxter, E.E. 198X. Vascular plants of the meadow at Big Meadows, Shenandoah National Park, Virginia. Unpublished report. ▪ Baxter, E.E. 1992. Species list: vascular plants of the meadow and adjacent swampy openings, Big Meadows, Shenandoah National Park. Unpublished report. ▪ Lobstein, M.B. 1992. Spring wildflowers- Shenandoah National Park- Blandy farm area. Unpublished report. ▪ Ludwig, J.C., G.P. Fleming, C.A. Pague, T.J. Rawinski. 1993. A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia: Shenandoah National Park. Natural Heritage Technical Report #93-5. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
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4.2 Scoping Workshops

A scoping workshop was held on April 3, 2001 at the Richmond National Battlefield Park in Richmond, VA (Workshop Summary, Appendix A). Thirty-five people attended including both National and Regional I&M Program staff, resource managers from the Network's VA parks, scientists from outside agencies and local universities, as well as local taxonomic experts (Table 4). The goal of the workshop was to identify gaps in vertebrate and vascular plant inventories in the parks by having those attending review existing species lists and information as well as develop a plan that included possible sampling protocols and cost estimates to complete the necessary inventory work. Prior to the workshop, participants were sent the following information about each park:

- A park description
- The park's management issues
- Species lists for vertebrates and vascular plants in the park
- NRBib references pertaining to vertebrates and vascular plants for the park
- A list of the most recent or ongoing inventory work in the park

Table 4. Mid-Atlantic Network VA Park's Scoping Workshop Participant List

<u>Name</u>	<u>Expertise</u>	<u>Affiliation</u>
Jeff Trollinger	Terrestrial species	VADGIF
Bryan Watts	Birds	Cen. for Conserv. Bio. ,William and Mary
Mark Wotawa	Sample design, Info Mgmt, Data analysis	NPS
Marcus Koenen	Birds	NPS- National Capital Region
Alan Williams	Birds, database mgt.	Shenandoah National Park
Jeff Hatfield	Biostatistics	USGS Patuxent
Deanna Dawson	Birds	USGS Patuxent
Wendy Cass	Botany	Shenandoah National Park
Gary Somers	Division Chief, Natural and Cultural Resources	Shenandoah National Park
Chris Ludwig	RTE Species	Division of Natural Heritage
Kent Schwarzkopf	Vascular plants	Appalachian Nat. Scenic Trail
John Dodge	Vascular plants	Private Consultant
Timothy Sims	Agricultural use in NPS	BOWA
Nancy Cowden	Vascular Plants	Lynchburg College
Timothy Blumenschine	Mammals	PETE
Ron Barry	Mammals	Frostburg State University
Allan O'Connell	Mammals	Patuxent Wildlife Research Center
Kristen G. Allen	Plant ecology/general ecology	RICH
John Pagels	Mammals	Virginia Commonwealth University
John Karish	Forestry/research admin.	NPS
Jim Atkinson	Biologist	Shenandoah NP
Bud LaRoche	Fisheries	VADGIF
Tom Shahady	Freshwater Biology	Lynchburg College
John Galvez, PhD	Fisheries	USFWS
Shelly Miller	Aquatic ecology, fish, mussels, herps	VADGIF
Rijk Morawe	Park Natural and Cultural Program	GEWA
Gary Swihart	Fisheries	USFWS
John Odenkirk	Fisheries	VADGIF
Sara Stevens	I&M	Northeast Region I&M Research Assoc.
Beth Johnson	I&M	Northeast Region I&M Coordinator

At the workshop, participants split up into workgroups based upon their taxonomic expertise. The workgroups included fish, mammals, birds, herps and plants. Each workgroup was asked to complete the following tasks:

- Review existing inventory data for vertebrate and vascular plant species in the network parks.
- Identify gaps in presence/absence data for vertebrate and vascular plant species existing within the network.
- Prioritize baseline inventories for the network.
- Articulate rationale for the prioritization of these inventories.
- Develop sampling schemes and cost estimates for network-wide inventories.

At the end of the day, all workgroups came together to report on what inventory gaps they had identified for each taxa and to present a list of prioritized inventories necessary to fill those gaps. This process was very successful.

PA Park Meetings

Scoping workshops were not held for the four, PA parks, GETT, EISE, VAFO and HOFU. Unlike the other seven parks in the Network, these four parks have received substantial regional funding for inventory work on vertebrates and vascular plants in the last five years. Instead of scoping workshops, meetings were held for these parks in the fall of 1999 and spring 2001 at Penn State University. These meetings were held to keep park staff updated on the progress and issues faced by the I&M Program and to have researchers who have been funded to do inventory work in their parks give an overview and update on their findings. In order to keep costs low, four other PA parks from the Eastern Rivers and Mountains Network were also included in these meetings. The regional I&M staff decided that a meeting to educate park staff and cooperators about the goals of the I&M Program was important, as well as hearing progress reports from cooperators doing baseline inventories. This would also help to assure that studies underway would meet I&M goals for sampling and data management. Table 5 is a list of people who attended the meetings.

Table 5. Mid-Atlantic Network PA park meetings participant list.

Name	Affiliation
Dr. Richard Yahner	Penn State University
Brad Ross	RA Penn State University
Dr. Harry Tiebout	West Chester University of PA
Dr. Brian Paulson	California University of PA
Timothy Stecko	Penn State University
John Karish	NPS Chief Scientist NE
Beth Johnson	Regional I&M Coordinator
Bert Frost	NPS-GETT/EISE
Connie Ranson	NPS-FONE/FRHI
Brian Eick	NPS- ALPO/JOFL
Brian Lambert	NPS-VAFO
Ed Clark	NPS-HOFU

The meeting agenda's included:

- Reviewing the goals of the I&M Program with the parks and cooperating scientists, by Beth Johnson, Northeast Regional I&M Coordinator.
- A progress report on avian inventories taking place at EISE, GETT, HOFU and VAFO by Dr. Richard Yahner from Penn State University and Research Associate, Brad Ross.
- A progress report on the herpetological inventories taking place at VAFO and HOFU, by Dr. Harry Tiebout from Westchester University of Pennsylvania.
- A progress report on the fish voucher search being conducted by Dr. Jay Stauffer from Penn State University and Research Associate, Tim Stecko.
- Discussion of product specifications for the Northeast Region I&M Program by Dr. John Karish, NPS.
- Update and review of the NPSpecies database by Penn State University Research Associate hired to work on the database for the Network.

4.3 Descriptions of Inventory Projects in Progress

As part of this data and information gathering process to determine the completeness of inventory work for vertebrate and vascular plant species in the Mid-Atlantic Network parks, information on both completed and currently funded projects was compiled and reviewed. A great deal of funding has been allocated through various funding sources for inventory work in the PA parks. Although these projects have not been funded by the I&M Program, it has been stated in all cooperative agreements that deliverables must follow I&M formats.

Herpetological Inventories

VAFO and HOFU

Dr. Harry Tiebout from West Chester University in PA is currently conducting herpetological inventories at both VAFO and HOFU. Field censusing began in September 1999 and will be completed by August 2001 at VAFO. To date 30 species have been recorded for the park, eight of which are new species for the park's list. Field censusing began, March 2001 at HOFU and will be completed by November 2001. As of June, seven new species had been added to the park's list, as well as several potential Bog Turtle habitats that will need further evaluation.

GETT and EISE

Dr. Richard Yahner, Katherine L. Derge and Jennifer Mravintz from Penn State University conducted an inventory of amphibians and reptiles at GETT and EISE from March-November 1999 and 2000 (Yahner et. al., 2001). The objectives of this project were to review existing literature and documentation of the NPS and other sources and develop a database of historic and potential occurrence of amphibians and reptiles at GETT and EISE. Presence, relative abundance and distribution of herps at both parks were determined and recommendations for ecological monitoring provided.

Avian Inventories

HOFU, VAFO, EISE, GETT

Currently, a comprehensive avian inventory is being conducted at HOFU, VAFO, EISE and GETT as part of a cooperative agreement with Penn State University (Yahner et al, 1999). The project began in 1999 and should be complete by 2002. As part of this inventory, more species specific inventories will take place at HOFU, VAFO and GETT on grassland birds. The objectives of the grassland bird research are (1) to determine and compare the density and species composition of birds in grasslands for GETT, HOFU, and VAFO, (2) to determine associations between the density and species composition of birds and grassland characteristics (e.g., vegetation and size) and landscape characteristics surrounding each grassland (e.g., percent forested land, developed land, and herbaceous vegetation), and (3) to determine and compare nesting success of select bird species in grasslands between GETT, HOFU, and VAFO. This research will provide valuable information concerning the status of grassland bird populations and possible suggestions of how to manage grasslands to maintain or possibly improve conditions for grassland birds within the national parks.

Another aspect of this research will be to determine the total number of species (i.e., species richness) in each park. Knowledge of this is important for long-term monitoring and maintenance of biological diversity. Although species richness is a basic ecological concept, it is often difficult to accurately quantify. Yahner and colleagues are currently exploring three complimentary ways to determine species richness for the national parks in their study. Based on point count data they are determining the observed species richness for each area. Observed species richness has the advantage of producing a list of species known to be present. By exploring various methods of determining species richness, the researchers expect to determine a range (and associated confidence) of potential species richness for each park. This information can be used by park managers to evaluate the importance and effectiveness of the park for the long-term maintenance of avian diversity and to provide guidance for habitat management and conservation.

Plant Inventories

APCO, BOWA, FRSP, PETE, RICH, & SHEN

The Virginia Invasive Vegetation Management Team Project (VIVMT) Project is tasked with assessing invasive vegetation problems at each VA-Subcluster host park, creating strategic plans, initiating controls against targeted invasives, assisting parks with site restoration, and moreover, creating a sustainable program that survives beyond the funding period. A strategic plan for managing alien invasive vegetation will be completed for each park. Monitoring plots will be established in all parks and field data collected and entered into a database for each park.

APCO, BOWA, FRSP, PETE, and RICH

These five parks were funded by the NPS Vegetation Mapping and Fire Program to develop vegetation/fire fuels maps over the next five years. North Carolina State University, the VA Natural Heritage Program and the Association for Biodiversity Inventory (ABI), will be cooperating with the NPS to create these maps. Kucera, Inc. will complete photography spring and fall, 2002 to the scale of 1:6000. During the VA scoping workshop it was decided that plant inventories in these five parks would not be a priority at this point, until all of the vegetation plot data from VA Natural Heritage was complete and the completeness of these inventories determined. It is suspected that at least 75% of the existing plant species will be inventoried during the mapping/classification process.

Fish Inventories

All Mid-Atlantic parks

Dr. Jay Stauffer and Timothy Stecko from Penn State University are conducting a fish voucher search for Northeast region parks in PA, MD, VA, NY, and WVA. All of the Mid-Atlantic Network parks are included in this search. The project entails putting together species lists, gathering distribution maps, and catalog information of fishes collected in and adjacent to national parks in these three states. Parks are being contacted for information regarding scientific collections permitting within the park. If fish collections are known to have occurred within the park the collector(s) are being contacted and the fish data obtained. Collections made near each park can also provide important information about fish distributed within, therefore each state's fish management agency is being contacted as well to determine other fish data sources. A list is being developed of all entities known to have conducted fish surveys within each state. All data collected during this project will be entered in the NPSpecies database as well as a relational database linked to the GIS Theme Manager.

4.4 Inventory Gaps

The following tables were developed after references, inventories in progress and scoping workshop results were reviewed. Based on these three sources of information it was determined whether or not baseline inventories for a taxonomic group were thought to be complete or incomplete (Table 6). Inventories in progress are noted. From this, a list of projects were identified for the Network (Table 7).

Table 6. Status of baseline inventories for vertebrate and vascular plant species for the eleven parks in the Mid-Atlantic Network. The shaded areas indicate gaps in baseline inventory data.

Park	Plants	Fish	Herps	Mammals	Birds
GETT	Baseline data complete-Veg Map planned	Voucher Inventory in Progress	Baseline data complete	Baseline data complete	Inventory in progress
EISE	Baseline data complete-Veg Map planned	Voucher Inventory in Progress	Baseline data complete	Baseline data complete	Inventory in progress
VAFO	Baseline data complete-Veg Map planned	Voucher Inventory in Progress	Inventory in progress	Baseline data complete	Inventory in progress
HOFU	Baseline data complete-Veg Map planned	Voucher Inventory in Progress	Inventory in progress	Baseline data complete	Inventory in progress
BOWA	Status to be determined after Veg Mapping	Voucher Inventory in Progress	Baseline data incomplete	Baseline data incomplete	Baseline data incomplete
RICH	Status to be determined after Veg Mapping	Voucher Inventory in Progress	Baseline data incomplete	Baseline data incomplete	Baseline data incomplete
APCO	Status to be determined after Veg Mapping	Voucher Inventory in Progress	Baseline data incomplete	Baseline data incomplete	Baseline data incomplete
FRSP	Status to be determined after Veg Mapping	Voucher Inventory in Progress	Baseline data incomplete	Baseline data incomplete	Baseline data incomplete
PETE	Status to be determined after Veg Mapping	Voucher Inventory in Progress	Baseline data incomplete	Baseline data incomplete	Baseline data incomplete
SHEN	Baseline data complete	Baseline data complete	Baseline data complete	Baseline data complete	Baseline data complete
APPA	Data Mining needed-Status of Baseline data to be determined	Data Mining needed	Data Mining needed	Data Mining needed	Data Mining needed

Table 7. Inventory Projects Identified by the Mid-Atlantic Network.

Park	Inventory Project
RICH/PETE/BOWA/APCO/FRSP	Baseline Mammal Inventory
RICH/PETE/BOWA/APCO/FRSP	Baseline Bird Inventory
RICH/PETE/BOWA/APCO/FRSP	Search State biodiversity database and identify gaps in fish data.
RICH/PETE/BOWA/APCO/FRSP	Baseline Herp Inventory
PETE	Colonial Waterbird Survey
EISE/GETT/VAFO/HOFU/RICH/PETE/BOWA/APCO/FRSP	Baseline Bat Inventory
APPA	Database development (Compile State Heritage Data)

4.5 Prioritization, Justification and Selection of Inventories

As shown in table 6 above, the shaded areas refer to those taxa in which no credible scientific inventory work has been completed. All of the shaded areas fall within the Mid-Atlantic VA parks and refer to birds, mammals, fish, and herps. After discussion at the scoping workshop held for the Virginia parks, experts and resource managers decided that it was most important to complete baseline inventories for these taxonomic groups lacking in information. It was agreed upon that herp inventories would be the most important to, but in general, the goal is to complete inventories for all four taxa either through the use of I&M funds or other funding sources.

Herp reconnaissance at BOWA, PETE, RICH, FRSP and APCO was suggested in order to better determine the extent of necessary funding to complete a herpetological inventory in these five parks. The group of fisheries experts at the meeting agreed that fish could be inventoried relatively inexpensively. VA DGIF staff went further and offered to search their extensive state species database for fish species collected in the parks, to help us better determine gaps in fish inventories. Once gaps are identified, local DGIF fisheries biologists will complete the work at no cost to the Network. The working group on birds suggested inventorying birds via the use of volunteers to help keep costs down.

Resource Managers in the PA parks in the Mid-Atlantic Network identified bats as the largest species group lacking in baseline inventory data in their parks. A small share of the Network inventory funding will be allocated to these parks for bat reconnaissance/surveys. The PA parks in the Mid-Atlantic Network have received a tremendous amount of funding for vertebrate and vascular plant inventories over the years. Because the VA parks have received such little funding for biological inventories, they will receive the majority of Network funding in order to counterbalance the extensive work and funding provided to the PA parks.

APPA

Inventories for the Appalachian Trail cannot be prioritized at this time. Data mining and park database development are underway and must be completed before data gaps can be identified and prioritized for limited funding. Fourteen states worth of existing State Natural Heritage Program data must be gathered and entered into NPSpecies and a relational database for the park. GIS coverages need to be acquired or developed for all this data as well.

The AT has been a major player in identifying natural heritage sites along the trail. They paid for most of the field work and provided the hard copy data to state natural heritage programs. We approached ABI (Association for Biotic Integrity) to compile a natural heritage data set from 14 state programs. The data set was to be in a standard, contiguous format and would include updates to recent occurrences and current state

rankings. ABI has existing agreement with states. It is ABI's intent to develop a contiguous data set of natural heritage information nationwide. Unfortunately, ABI's cost estimate for the work was well over \$100,000 and they had concerns about the function of acquired data in our system – how would it be used, by how many and what occurrences (candidate, listed, rare, threatened) did we want. Based on the response from ABI, the park resource manager began contacting state natural heritage programs to request data. A decision was made to hire temporary staff to be stationed with AT staff to continue data acquisition in this manner. The new staff will contact the 14 state heritage programs, acquire the trail's RTE species data and build databases and GIS themes for the park.

Another project that is priority for APPA is data mining beyond state natural heritage programs. The park will hire another technician to contact universities, subject matter experts and local groups in each state who may have been or currently collecting species data in or adjacent to the Trail. This technician will work closely with Scott Tiffney, science librarian, working on the NRBIB database to identify initial contacts. Once the state RTE data is gathered, the park's NRBIB (2002) and additional data mining is completed, the park will then be better able to identify their inventory needs. A scoping process will be used.

SECTION V-MEETING THE NETWORK GOALS

INVENTORY GOAL 1

Data Management and relational database development of existing, large, network data sets.

Project 1 Network Data Manager

Total \$75,791 (2003-2004 request)

Description: (Scope of work to be written) A full-time term data manager will be hired in 2003 for the Mid-Atlantic Network to begin managing and coordinating existing and newly acquired. The Network has many large data sets scattered throughout the Network that need to be compiled, as well as projects close to completion. The data manager will be in charge of completing a data inventory for the Network, making sure that all scientifically based existing data is in a useable format for the parks and will be available for future planning of the Network's long-term monitoring program.

Project 2 APPA GIS Technician

Total \$20,000 (2002 APPA I&M Funds)

Proposal

Appalachian National Scenic Trail Natural Heritage Inventory GIS

Background and Problem Statement:

The Appalachian National Scenic Trail is 2,160 miles long and traverses 14 states from Georgia to Maine. The Trail passes through many natural environments including areas containing rare and threatened species. Natural Heritage Inventories for vascular plants and some animal groups were completed for all 14 Appalachian Trail states. Much of the information (including the location) pertaining to these species resides in state Natural Heritage Program GIS databases or paper reports and maps. It is critical for proper trail management that this information be incorporated into the NPS Appalachian Trail Park Office (ATPO) GIS database.

A survey of the 14 State Natural Heritage Programs revealed:

Four state NHP offices (**Maine, Virginia, Tennessee, and Georgia**) indicated they have NHP GIS data and are willing to share this information with ATPO, but will require data sharing or license agreements. Tennessee may require a license fee. They indicated that their information was taken from the written Appalachian Trail NHP inventory reports or other sources. Maine used their existing GIS database when creating the written reports. ATPO sent formal requests for the license agreements to the state NHP offices.

New Hampshire has not been contacted but the state is known to have GIS data; the state's willingness to share information is not known at this point.

Connecticut released generalized data to ATPO. However, after evaluating this data, we feel it is too general to meet our specific trail and land management needs. The data simply shows areas of concern through large polygons or point locations, but no attributes. The Appalachian Trail intersects at least 30 of these areas. They are not willing to release attribute information, but instead would like ATPO to contact them when we propose work in these sensitive areas. The Trail in Connecticut is approximately 48 miles long, so it is feasible we could digitize this information in-house from the CT NHP report.

New Jersey, New York, and Maryland inventories were recently completed, but to the best of our knowledge GIS data has not been created yet. The trail mileage in these states is relatively small so we could digitize the maps from the reports.

Vermont, Massachusetts and Pennsylvania have not responded to voice messages.

West Virginia NHP data was digitized by the Appalachian Trail Conference GIS Specialist. The data are in ATPO GIS, no further work is anticipated.

Data was received from **North Carolina**. They did not require a license agreement, but stipulated that they remain the primary owners of this information; therefore the data cannot be redistributed. The data still needs to be evaluated to make sure it meets our management needs.

Although this assessment reveals that much of the information we need may be in GIS format and is available from the state NHP offices, an evaluation of these data must still take place. Time and energy will also be needed to massage and combine these individual datasets into one large database for the entire Trail.

Proposal:

A major goal of ATPO is to get all the Natural Heritage Inventory data for all 14 states into our GIS. The inventory data will allow ATPO to monitor and manage sites more effectively. We will be able to analyze the

effects of trail maintenance, relocations, encroachments, high use areas, etc., on rare plants, animals, and natural communities. This digital information will help ATPO take a proactive role in protecting these species. As indicated above, much of this data can be obtained from the state NHP offices, but some will have to be created in-house through digitizing the NHP reports. In addition, these data must be merged and formatted in a “user friendly” way for trail management staff.

It is difficult to know exactly how much time is needed to complete this project since we will not know the condition of the data until we receive it; plus many maps may still need to be digitized. If the project is completed and resources remain, then work would shift to other projects related to GIS and natural heritage inventorying (i.e. making maps for trail managers, GPS fieldwork where data is incomplete, database updates, etc.) This project could be accomplished either through a contractor or by hiring a seasonal employee. Based on costs for a 1080-hour seasonal position at the GS 5-7 level, it is estimated that \$15,000 - \$20,000 will be required to complete this project.

INVENTORY GOAL 2

To conduct baseline presence/presence not detected inventories on those taxonomic groups identified as having incomplete data.

Project 3 Mammalian Inventories at FRSP and RICH

Note: Two cooperators were identified to inventory mammals in five of the Mid-Atlantic VA parks, Dr. Ron Barry and Dr. John Pagels. Dr. Ron Barry has also submitted a proposal to complete mammal inventories in other Network parks and was only able to include two of the VA Mid-Atlantic parks, therefore another cooperator was approached. Both cooperators plan on working with each other in terms of using the same protocols etc...

Total \$64,126 (2003 request)

Proposal

Title: Mammal Surveys in Fredericksburg and Spotsylvania Co. Memorial National Military Park and Richmond National Battlefield Park (RICH)

Principle Investigator: Dr. Ronald E. Barry, Department of Biology, Frostburg State University

Overview

The National Park Service (NPS) has identified the need for surveys of mammals in five mid-Atlantic national parks in the Northeast Region. Acquiring such natural resource information is in compliance with the Vail Agenda mandate to the NPS's Natural Resource Inventory and Monitoring Program (NPS 1998). One of the five long-term goals established by this program is to complete baseline inventories of basic biological and geophysical natural resources for the national parks. During Phase I of the natural resource inventory the NPS has set an objective of documenting the presence of at least 80% of all plant and animal species (excluding invertebrates) occurring within a park's boundaries; the stated objective for the mammal survey of the parks of the Northeast Region is 90%. Surveys will confirm the existence of currently listed species and document the

presence of new ones. The data collected provide important baseline information that can be used by natural resource specialists in monitoring programs to note changes and quantify trends in resources and relate variation in time to potential causes. Such monitoring programs can result in management decisions that effect proper stewardship of the park system by NPS.

I propose to conduct surveys of mammals in 2 mid-Atlantic parks: Fredericksburg and Spotsylvania Co. Memorial National Military Park (FRSP) and Richmond National Battlefield Park (RICH). FRSP is comprised of 6,789 acres (2,749 ha) within 9 units in and west of Fredericksburg, Virginia, in Spotsylvania, Stafford, Orange and Caroline counties. The park was established in 1927. FRSP consists of 5,137 acres (2,080 ha) of oak/hickory/pine woodland, 1,052 acres (426 ha) of agricultural and mown fields, and approximately 600 acres (243 ha) of wetlands. RICH occupies 764 acres (309 ha) within 11 separate units (eight with natural habitats) in and east of Richmond, Virginia, in Hanover, Chesterfield and Henrico counties. An additional 1,300 acres (526 ha) will soon be added to the park. The park was established in 1936. Approximately 570 acres (231 ha) is oak/hickory/pine woodland, 110 acres (45 ha) leased for agriculture or is in mown fields, and the remainder, riparian wetland.

The NPFauna (2001) database lists records of only 4 species of mammals (orders Rodentia, Artiodactyla and Carnivora) in the FRSP. The database lists 9 records of mammals (orders Marsupialia [Didelphimorphia], Rodentia, Artiodactyla, and Carnivora) for the RICH.

Project Description

Goal

The primary goal of the proposed project is to survey the mammals (excluding bats) of FRSP and RICH with the purpose of documenting $\geq 90\%$ of the species that occupy each of these parks and describing the relative abundance of species of concern. A secondary goal associated with graduate student thesis projects is to provide information on mammal communities of the parks.

Objectives

Primary

1. Review all natural resource studies that have occurred within the parks' boundaries and all historical scientific material stored in the parks to develop a database of mammal species (excluding bats) that possibly occur in the parks.
2. Conduct extensive surveys of the parks for, and catalog, the presence, distribution, and relative abundance (for species of concern) of mammal species in forests, fields, riparian areas, marshes, rocky outcrops, etc. at FRSP and RICH.

Secondary (graduate student theses)

1. Describe habitat- (and potentially park unit-) specific species diversity in the 2 parks.

2. Assess the status of mammals within each of the parks and provide recommendations for monitoring mammal populations.

Methods

Historical records.--Initially we will establish an electronic database (Microsoft Access 2000) of records of mammal species for each of the 2 parks from existing databases such as NPFauna (2001), park records, records of museums such as the U.S. National Museum (Smithsonian), university/college and local collections and museums, and published literature. The database should be compatible with that of other national park units and NPFauna (2001) so that information can be used at the ecosystem and landscape levels (NPS 1998). The database will contain at least the complete taxonomy (Wilson and Reeder 1993; Jones et al. 1997) and common name (Wilson and Ruff 1999) of each species, location (park) of each species, and source of the record.

Delineation of habitats.--The recognition of major habitat types will allow stratification of the sampling effort in the 2 parks. This will ensure a representative and comprehensive survey of the small mammal fauna by increasing the efficiency with which individual species are detected, particularly those that are rare. Habitats will be identified by GIS cover maps, if available, or aerial photos. Topographic maps will be important in identifying habitat potentially important to (or avoided by) certain species. Major habitat types should include, but not be limited to, forests (deciduous, coniferous, mixed, and wetland), grasslands, agricultural fields, and riparian zones. In addition, recognizable corridors (of various habitat types) will be identified and sampled. Strata will be ground-truthed before final selection of sampling sites. Because habitat changes over time, permanent boundaries of original strata will be delineated on GIS maps to permit long-term monitoring of animal populations and vegetation (NPS 2000).

Sampling protocol.--Sampling sites will be located within well-defined habitat types (see above) to permit stratified sampling for developing a representative list of species and an efficient means for monitoring and managing populations. In addition, unusual or less common or expansive habitats (e.g., bogs) will be sampled because they often harbor small populations or rare species important in monitoring the health of an ecosystem or landscape. The number of sampling locations (sample units) within any single park will be dependent on the number of park units, number, size and distribution of habitat types, and constraints imposed by accessibility, equipment and personnel. Historical records and site visits to a park, once habitats are defined, will be factors in determining the number of sampling locations. Sampling on private property will occur only with the permission of the landowner.

To identify sampling points, systematic grids will be superimposed on park maps that depict habitat types (NPS 2000). Points on a grid, within a habitat type, will be selected without replacement by the generation of random numbers (either computer-generated or from a random numbers table) representing grid cells (Rudran and Foster 1996). Edge areas (habitat edge, roads, etc.) known to influence species richness and abundance of mammals (e.g., Cummings and Vessey 1994), portions of parks frequented by the public, and areas inaccessible to ground personnel will be removed from consideration as sampling locations. Once selected on a map, a sampling location will be located in real space using differentially corrected GPS. Before sampling begins, a review of sampling locations and times will be solicited from park management.

Sampling will rely on capture of small mammals using primarily Sherman and Tomahawk live traps (for larger shrews, mice and voles, squirrels, etc.) and pitfall trap arrays (for shrews and small mammals < 10 g -- Kirkland and Sheppard 1994). Sherman live traps are generally highly effective for capture of rodents and large shrews

such as *Blarina* spp. (Mitchell et al. 1993). However, as recently as 1987 the pygmy shrew (*Sorex hoyi*) was thought to be extremely rare in Virginia (Pagels 1987), but with the later use of pitfall traps the species is now known to be relatively common in certain situations (Pagels et al. 1992, and others). Pitfalls for shrews are generally used as kill-type traps with fluid in the bottom because individuals must be collected and examined closely (often microscopically) for identification to species and sex. Traps will be arrayed at sampling points in randomly positioned linear transects or grids, with the number of traps and trap spacing dependent on habitat type and patch size (Jones et al. 1996). The trapping effort needed to account for $\geq 90\%$ of all species within each habitat within each park or park unit will be determined by a species accumulation curve; once a plateau (asymptote) is reached, sampling will cease, at least for that sampling period. This sampling regime will permit a measure of species richness and relative abundance for each park. Locations for sampling small mammals will generate observations and signs of larger mammals; species, location and date for each such mammalian encounter will be recorded on data sheets for inclusion in the database for the park. Tomahawk traps used for capturing larger mammals for species identification will be placed in locations where sign is detected or where habitat features suggest the presence of these species. Remote cameras will be used to document the presence of large, secretive and elusive species. When feasible, night-vision binoculars will be used to determine presence of medium- and large-sized mammals.

Habitat at each sampling location will be characterized by such features [at randomly selected sites] as dominant vegetation, percent canopy cover, abundance of shrub and ground cover, degree of disturbance (e.g., primary or secondary forest or plantation, agricultural use of grassland, frequency of fire or flooding), substrate and soil type, presence of rock piles, topography and elevation (Barry et al. 1999; Boyce 2001; McDiarmid and Wilson 1996). Temperature and precipitation for sampling dates will be obtained from the park weather station or the nearest available weather station if none exists within the park.

Captured individuals of small species (those in Sherman and pitfall traps) will be removed from traps (Jones et al. 1996), identified to species, weighed using a Pesola scale, and examined for age, sex, and reproductive condition. Individuals captured in Tomahawk traps will be identified to species, and, if practical, weighed using a Pesola scale and examined for age, sex and reproductive condition. Because recognition of individuals is necessary for determining relative abundances (NPS priority for species of concern) and measures of species diversity (graduate student theses projects), captured individuals may be marked by spot-shaving, hair-dyeing, ear-tagging (Monel #1 tags, National Band and Tag Co., Newport, Kentucky) or toe-clipping (ASM 1998; Rudran 1996). To obtain meaningful scientific data, most shrews will be taken (unless mandated otherwise by the NPS). Shrews, including the large *Blarina* spp., are almost impossible to sex or age in the field unless they are pregnant or lactating females. In addition, a minimum of five species of shrews might be expected at sites to be studied, four at any one site. Two pairs of species, the northern (*B. brevicauda*) and southern (*B. carolinensis*) short-tailed shrews and the pygmy and southeastern (*Sorex longirostris*) shrew, are very difficult to distinguish in the field. Release will be immediate at the capture location. Live-trapping and handling procedures will be administered humanely (Rudran and Kunz 1996) and be consistent with the animal handling guidelines of the American Society of Mammalogists (ASM 1998). Also, proper precautions will be taken by investigators to prevent human injury and exposure to disease, especially rabies, Lyme disease, hantaviral pulmonary syndrome (HPS), and human ehrlichiosis (Gage et al. 1995; Kunz et al. 1996; Mills et al. 1995). Animals found dead in traps (most frequently in pitfalls), if salvageable, will be collected, prepared, deposited and maintained in the Frostburg State University (FSU) mammal museum (see below).

Compilation and analysis of data.--Data on habitat and all mammals captured or observed (including sign) will be stored in an electronic database (Microsoft Access; see **Deliverables** below). These data will be combined

with historical data to determine the number of species in a park. Current data will be used to determine distribution and habitat of species. Associations of species with habitat type and variables, and determination of relative abundance, will rely on such customary statistical procedures as regression, ANOVA, chi-square, and log-likelihood analyses (Zar 1999). Estimates of species diversity, richness and evenness for graduate student thesis projects will derive from customary models (e.g., Shannon-Wiener index, rarefaction, and Pielou's J' – Krebs 1999) to facilitate comparisons among habitats, parks, park units, and investigators and at various sample sizes. Statistical analysis will be conducted at Frostburg State University. The final report will include, for each park, records of all mammal species and their distributions, relative abundances of species of concern, survey methods and weather conditions, locations of voucher specimens, and recommendations for long-term monitoring for use by park management.

Project Coordination

Project personnel will include the project director (cooperator) and 3 graduate student investigators, one assigned to RICH and the other two to FRSP. The project director will oversee all activities. Park staff will be notified beforehand by phone or e-mail of all project activities to be undertaken in the park. Monthly schedules, developed in coordination with park management, will be produced by project investigators. Schedules will be adhered to as closely as possible but be subject to change due to weather or unforeseen personnel circumstances; changes in schedule will be communicated in advance by project investigators. The project director will obtain park permits and a state scientific research and collecting permit for conducting the research, collecting specimens, and depositing specimens in the mammal museum at Frostburg State University; investigators (subpermittees) will carry copies of the permits during sampling. In addition, the project director will obtain approval from the Institutional Review Board/Animal Care and Use Committee at Frostburg State University to conduct the research. Where park housing is available, project investigators may submit requests for overnight stays when this is necessary for survey work. The project director will negotiate with park management and natural resource personnel any use of park equipment (e.g., GPS) that can facilitate data collection and contribute to the successful completion of the project.

Deliverables

Species data

Field forms will be provided, upon request, to the NPS I & M Program.

Digital data sets will be produced in Microsoft Access format, using the NPS I & M template (www1.nature.nps.gov/im/apps/template/) or one specifically developed for the particular project.

GPS data

GPS coordinates, differentially corrected, will be provided in ArcInfo format or as an ArcView file for all sampling locations and observation sites.

Metadata

Metadata will be provided in Dataset Catalog format (nonspatial data) or, with the cooperation of NPS data managers, in Federal Geographic Data Committee (FGDC) format (spatial data) found at www.fgdc.gov/metadata/metadata.html.

Voucher specimens

The mammal museum of the Department of Biology at Frostburg State University will be the repository of voucher specimens (Reynolds et al. 1996) and any salvageable individuals dead in traps or encountered as roadkills. Where possible, individuals found dead will be prepared as voucher specimens, either dry skin and skull preparations or fluid-preserved whole. Otherwise, voucher specimens of small mammals (shrews, voles, mice and rats) will be obtained from individuals captured live and euthanized by cervical dislocation or thoracic compression (ASM 1998) or selective kill trapping using Museum Special snap traps (Woodstream Corporation, Lititz, Pennsylvania) or pitfall traps. Specimens of only those species for which no record exists for the park will be sought. Moles, medium- and large-sized mammals will be documented as photo vouchers; photo vouchers or specimen vouchers from trap mortalities, roadkills or individuals found dead; or collection of sign. Threatened and endangered species will not be sacrificed for voucher specimens; photo documentation will be made where possible and/or hair samples will be collected. Specimens deposited at FSU will be catalogued in the University's database.

Reports

Progress reports will be submitted annually. A draft of the final report will be submitted digitally to the Northeast Region, I & M Program. The final report will be submitted digitally and in hard copy. Graduate student theses incorporating work done to fulfill requirements of this agreement will be submitted in hard copy.

Bibliographic citations

A reprint will be provided for each publication or thesis based on work completed under this agreement.

Project Timetable

<u>Dates</u>	<u>Activities</u>
January-May 2003	Obtain historical records of mammals for RICH, outline and ground-truth strata and establish sampling sites, establish sampling protocol, design database (template)
March-November 2003	Conduct survey of mammals at RICH, refine sampling protocol, establish procedures for data analyses
August – December 2003	Obtain historical records of mammals of FRSP, outline and ground-truth strata and establish sampling sites, establish sampling protocol, design database (template), conduct survey of mammals
November 2003-January 2004	Prepare progress report
March-November 2004	Complete survey of mammals at RICH, compile data; conduct survey of mammals at FRSP, refine sampling protocol, establish procedures for data analyses
November 2004-January 2005	Analyze data, prepare progress report
March – November 2005	Complete survey of mammals at FRSP, compile and analyze data
November 2005-January 2006	Analyze data, prepare final report (with species data, GPS data, metadata)

	Budget	
	Agency	FSU
	<u>Request</u>	<u>Match</u>
I. Personnel assignments and costs		
A. Dr. Ron Barry's release time/summer stipend - \$7,900/mo./yr. for 2 yrs.	\$15,800	\$15,800
B. RICH: 2-semester research assistantship (\$5,000) + 1-summer assistantship (\$2,000) + January stipend (2 nd yr. @ \$1000) for 1 graduate student (FSU match is 2-semester and summer assistantship)	8,000	7,000
C. FRSP: 2-semester research assistantship (@\$5,000) + 1-summer assistantship (@\$2,000) + January stipend (2 nd yr. @ \$1,000) for 2 graduate students (FSU match is 2-semester and summer assistantship for 2 students)	16,000	14,000
D. Tuition waiver for 3 graduate students @ \$3,600/yr./student for 2 yrs. each		21,600
E. Rabies vaccine – (3 series @ \$240) + (1 booster @ \$80)	800	
F. Student health insurance (Sentry Student Security Plan – E. J. Smith & Associates) for 3 graduate students @\$300/yr./student for 3 students for 2 yrs. each	1,800	
I. Total	\$42,400	\$58,400
II. Transportation*		
A. Roundtrip to RICH – (30 trips @ 420 mi/trip) + (30 mi/trip local travel X 4/trip X 30 trips) = 16,200 mi @ \$0.32/mi (FSU institutional rate)	\$4,406	\$ 778
B. Roundtrip to FRSP – (40 trips @ 160mi/trip) + (20 mi/trip local travel X 4/trip X 40 trips) = 9,600mi @ \$0.32/mi	2,611	461
C. Dr. Ron Barry's travel – 7,500 mi @ \$0.32/mi		2,400
II. Total	\$ 7,017	\$3,639
III. Lodging**		
Supplied by NPS. If not, lodging expenses are needed for 90 nights for RICH and 240 nights for FRSP.		
IV. Equipment, supplies, services, etc.		

A. Sherman live traps – 150 @ \$14.00 (-5%) + \$100 shipping	\$2,095	
B. Tomahawk single-door, collapsible (squirrel size) – 5 @ \$30.00	150	
C. SONY MVC-CD 1000 CD Mavica digital camera	1,000	
D. 5 silt fences (for pitfall arrays); 2' X 100' @ \$18.00	100	
E. Miscellaneous supplies (flagging, bait, stakes, sampling bags, trap bedding, specimen preparation supplies, map acquisition, ear tags, dye, computer supplies, field gear, EpiPen epinephrine kits, photocopying, etc.), shipping expenses for traps and other equipment and supplies, etc.	1,000	
F. Equipment, supplies, and additional support (traps, densiometers, compasses, measuring tapes, ear tags, Pesola scales, binoculars, night-vision binoculars, aerial photo stereoscope, specimen storage and maintenance, graduate faculty support, secretarial and technician support, photocopying and duplicating services, mail, etc.)		\$4,000
G. Computer services (data compilation and statistical analysis, report preparation, e-mail, etc.)		4,000
H. Attendance, paper presentation at professional meetings @ \$1,000/yr. for 2 yrs.	2,000	
IV. Total	\$ 6,345	\$8,000

Project Subtotal	\$55,762
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Indirect costs (15% according to CESU agreement)	\$ 8,364
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PROJECT TOTAL	\$64,126	\$70,039
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*** Based on 15% of mileage provided by FSU (plus Ron Barry's travel)**

**** If park lodging is not available, additional support is sought for local lodging for investigators**

Budget Justification

<u>Item #</u>	<u>Justification</u>
I. A	Support for the project director (cooperator) for either course release and/or summer salary for 2 years for project coordination, field work, data analysis, report preparation, etc.
I. B, C, D	Three graduate students are needed to conduct the proposed work within the proposed period. Support in the amount of a stipend for 1 academic year, summer, and January is requested for each of 3 students. FSU will provide a 2nd year (including summer) of stipend for each student.
I. D	Graduate tuition and fees @ \$200/credit X 36 credits/ student X 3 students
I. E	For 3 graduate students and project director (booster only)
I. F	Basic coverage (maximum \$3,000 benefit/yr.) for graduate students
II. A, B	Reimbursement for use of vehicles by investigators to travel to, from, and within study sites. FSU provides 15% of mileage.
II. C	FSU provides mileage for project director.
III.	If NPS lodging is not available, NPS support for such will be sought.
IV. A, B	Traps needed for simultaneous trapping of small mammals at 5 national parks
IV. C	Camera needed for voucher specimens, confirmation of identifications of amphibians and reptiles in pitfall traps, etc.
IV. D	Fencing needed to establish pitfall trap arrays (for capturing shrews and other small mammals < 10 g) at 3 national parks
IV. E	Self-explanatory
IV. F	Support from FSU's Department of Biology
IV. G	Support from FSU's Computing Services, Academic Computing, and departments of Biology and Mathematics
IV. H	Travel, registration, lodging, and meals for 3 graduate students and project director for 2 yrs.

Project 3b *Mammalian Inventories at BOWA, PETE and APCO*

Total \$68,875 (2002 request)

Proposal

Title: Mammal Surveys in Appomattox Court House National Historical Park, Booker T. Washington National Monument, and Petersburg National Battlefield

Principle Investigator: Dr. John F. Pagels, Department of Biology, Virginia Commonwealth University

Overview

The National Park Service (NPS) has identified the need for surveys of mammals in several National Parks in the mid-Atlantic Network. Acquiring such natural resource information is in compliance with the Vail Agenda mandate to the NPS's Natural Resource Inventory and Monitoring Program (NPS 1998). One of the five long-term goals established by this program is to complete baseline inventories of basic biological and geophysical natural resources for the national parks. During Phase I of the natural resource inventory the NPS has set an objective of documenting the presence of at least 80% of all plant and animal species (excluding invertebrates) occurring within a park's boundaries; the stated objective for the mammal survey of the parks of the Northeast Region is 90%. Surveys will confirm the existence of any currently listed species and document the presence of new ones. The data collected provide important baseline information that can be used by natural resource specialists in monitoring programs to note changes and quantify trends in resources and relate variation in time to potential causes. Such monitoring programs can result in management decisions that effect proper stewardship of the park system by NPS. Data obtained in the inventory will also serve as valuable baseline and historical documentation of the mammal fauna in portions of the Mid-Atlantic area at the beginning of the century.

I propose to conduct surveys of mammals in 3 Mid-Atlantic parks: Appomattox Court House National Historical Park (APCO), Booker T. Washington National Historical Park (BOWA), and Petersburg National Battlefield (PETE). APCO is located in the Piedmont physiographic region of south central Virginia 92 miles west of Richmond, and 18 miles east of the City of Lynchburg. APCO is comprised of 1743 acres, of which 1160 acres are wooded; 30 % of the woodlands are deciduous and the remainder conifers. The site also includes approximately 8 miles of riparian habitat along the Appomattox River and its tributaries. The site contains nearly 600 acres of open fields that include the historic village. BOWA is located in the high Piedmont 22 miles southeast of Roanoke. BOWA is comprised primarily of forests and open woodland but included in the 224 acres at BOWA are approximately 65 acres of pasture and hay fields. The approximately 125 acres of forest are about 20% conifer, mixed 55%, and deciduous 25%. The site includes numerous small streams. PETE encompasses 2700 acres in 10 separate units scattered over two counties, and in the cities of Petersburg and Hopewell. Approximately 2400 acres are wooded, and most of that is mixed forest. PETE includes approximately 14 miles of riparian habitat, most of which is overgrown or wooded. The two largest areas of the park are the Petersburg National Battlefield in Petersburg, and the Five Forks Battlefield located about 20 miles to the west

There are extremely few documented records of mammals at the three sites. The NPFauna (2001) database lists no records of mammals for APCO, only the white-tailed deer for PETE, and only the white-tailed deer for BOWA. Nineteen species are listed as “probably present” at BOWA.

Project Description

Goal

The primary goal of the proposed project is to survey the mammals (excluding bats) of APCO, BOWA, and PETE with the purpose of documenting $\geq 90\%$ of the species that occupy each of these parks and describing the relative abundance of species of concern. A secondary goal associated with graduate student thesis projects is to provide information on mammal communities of the parks.

Objectives

Primary

1. Review published literature to develop a database of mammal species that potentially occur within the parks.
2. Review all natural resource studies that have occurred within the parks' boundaries and all historical scientific material stored in the parks to develop a database of mammal species (excluding bats) that possibly occur in the parks.
3. Conduct extensive surveys of the parks for, and catalog, the presence, distribution, and relative abundance (for species of concern) of mammal species in forests, grasslands, agricultural fields, riparian areas, marshes, rock outcrops, etc. at APCO, BOWA, and PETE.
4. Describe habitat-specific species diversity in the 3 parks.
5. Assess the status of mammals within each of the parks and provide recommendations for monitoring mammal populations.

Secondary

Potential Graduate student thesis(es) To be arranged, may include part of the above.

Methods

Historical records.-In addition to establishing a list of potentially occurring species as based on experience of the principal investigator and published records, we will initially establish an electronic database (Microsoft Access 2000) of records of mammal species for each of the 3 parks from existing databases. Databases to be examined will include NPFauna (2001), park records, records of museums such as the U.S. National Museum (Smithsonian), university/college and local collections and museums, and published literature. The database should be compatible with that of other national park units and NPFauna (2001) so that information can be used at the ecosystem and landscape levels (NPS 1998). The database will contain at least the complete taxonomy

(Wilson and Reeder 1993; Jones et al. 1997) and common name of each species, location (park) of each species, and source of the record.

Delineation of habitats.-The recognition of major habitat types will allow stratification of the sampling effort in the 3 parks. This will ensure a representative and comprehensive survey of the small mammal fauna by increasing the efficiency with which individual species are detected, particularly those that are rare. Habitats will be identified by GIS cover maps, if available, or aerial photos as well as reconnaissance of the sites by the investigators. Topographic maps will be important in identifying habitat potentially important to (or avoided by) certain species. Major habitat types should include, but not be limited to, forests (deciduous, coniferous, mixed, and wetland), grasslands, agricultural fields, rock outcrops, riparian zones, and marshes. In addition, recognizable corridors (of various habitat types) will be identified and sampled. Strata will be ground-truthed before final selection of sampling sites. Because habitat changes over time, permanent boundaries of original strata will be delineated on GIS maps to permit long-term monitoring of animal populations and vegetation (NPS 2000).

Sampling protocol.-Sampling sites will be located within well-defined habitat types (see above) to permit stratified sampling for developing a representative list of species and an efficient means for monitoring and managing populations. In addition, unusual or less common or expansive habitats (e.g., bogs) will be sampled because they often harbor small populations or rare species important in monitoring the health of an ecosystem or landscape. The number of sampling locations (sample units) within any single park will be dependent on the number, size and distribution of habitat types and constraints imposed by accessibility, equipment and personnel. Historical records and site visits to a park, once habitats are defined, will be factors in determining the number of sampling locations. Sampling on private property will occur only with the permission of the landowner.

To identify sampling points, systematic grids will be superimposed on park maps that depict habitat types (NPS 2000). Points on a grid, within a habitat type, will be selected without replacement by the generation of random numbers (either computer-generated or from a random numbers table) representing grid cells (Rudran and Foster 1996). Edge areas (habitat edge, roads, etc.) known to influence species richness and abundance of mammals (e.g., Cummings and Vessey 1994), portions of parks frequented by the public, and areas inaccessible to ground personnel will be removed from consideration as sampling locations. Once selected on a map, a sampling location will be located in real space using differentially corrected GPS. Before sampling begins, a review of sampling locations and times will be solicited from park management.

Because there is much variation in the ability to catch mammals of various sizes and various groups, different trap types and sampling methods must be used for a complete inventory. Sherman live traps are generally highly effective for capture of many rodents, but not effective for shrews except the large members of the genus *Blarina* (Mitchell et al. 1993). For example, as recently as 1987, the pygmy shrew was thought to be extremely rare in Virginia (Pagels 1987), but with the later use of pitfall traps the species is now known to be relatively common in certain situations (Pagels et al. 1992, and others). Pitfalls for shrews are generally used as kill-type traps with fluid in the bottom. Sampling will rely on capture of small mammals using primarily Sherman and Tomahawk live traps (for larger shrews, mice and voles, squirrels, etc.) and pitfall trap arrays (for most shrews and select small mammals < 10 g -- Kirkland and Sheppard 1994). Traps will be arrayed at sampling points in randomly positioned linear transects or grids, with the number of traps and trap spacing dependent on habitat type and patch size (Jones et al. 1996). The trapping effort needed to account for $\geq 90\%$ of all species within each habitat will be determined by a species accumulation curve; once a plateau (asymptote) is reached,

sampling will cease, at least for that sampling period. This sampling regime will permit a measure of species richness and relative abundance for each park. Locations for sampling small mammals will generate observations and signs of larger mammals; species, location and date for each such mammalian encounter will be recorded on data sheets for inclusion in the database for the park. Tomahawk traps used for capturing larger mammals for species identification will be placed in locations where sign is detected or where habitat features suggest the presence of these species. Remote cameras will be used to document the presence of large, secretive and elusive species. When feasible night-vision binoculars will be used to determine presence of medium and large sized mammals.

Habitat at each sampling location will be characterized by such features [at randomly selected sites] as dominant vegetation, percent canopy cover, abundance of shrub and ground cover, degree of disturbance (e.g., primary or secondary forest or plantation, agricultural use of grassland, frequency of fire or flooding), substrate and soil type, presence of rock piles, topography and elevation (Barry et al. 1999; Boyce 2001; McDiarmid and Wilson 1996; Orrock et al. 2000; Pagels et al. 1994). Temperature and precipitation for sampling dates will be obtained from the park weather station or the nearest available weather station if none exists within the park.

Captured individuals of small species (those in Shermans) will be removed from traps (Jones et al. 1996), identified to species, weighed using a Pesola scale, and examined for age, sex, and reproductive condition. Individuals captured in Tomahawk traps will be identified to species, and, if practical, weighed using a Pesola scale and examined for age, sex and reproductive condition. Because recognition of individuals is necessary for determining relative abundances (NPS priority for species of concern) and measures of species diversity (potential graduate student theses projects), captured individuals may be marked by spot-shaving, hair-dyeing, ear-tagging (Monel #1 tags, National Band and Tag Co., Newport, Kentucky) or toe-clipping, (ASM 1998; Rudran 1996). In order to obtain meaningful scientific data, most shrews will be taken (unless mandated otherwise by the NPS). All shrews including the large *Blarina* species are almost impossible to sex or age in the field unless they are in the peak of reproductive condition, i.e. late pregnancy or lactating females. In addition, a minimum of 5 species of shrews should be expected at sites to be studied, four at any one site. Two pairs of species, the northern short-tailed shrew, *Blarina brevicauda*, and the southern short-tailed shrew, *B. carolinensis*, and the pygmy shrew, *Sorex hoyi*, and the southeastern shrew, *Sorex longirostris*, are very difficult to distinguish in the field. Otherwise, release will be immediate at the capture location. Live-trapping and handling procedures will be administered humanely (Rudran and Kunz 1996) and be consistent with the animal handling guidelines of the American Society of Mammalogists (ASM 1998). Also, proper precautions will be taken by investigators to prevent human injury and exposure to disease, especially rabies, Lyme disease, hantaviral pulmonary syndrome (HPS), and human ehrlichiosis (Gage et al. 1995; Kunz et al. 1996; Mills et al. 1995).

Compilation and analysis of data.-Data on habitat and all mammals captured or observed (including sign) will be stored in an electronic database (Microsoft Access; see **Deliverables** below). These data will be combined with historical data to determine the number of species in a park. Current data will be used to determine distribution and habitat of species. Associations of species with habitat type and variables, and determination of relative abundance, will rely on such customary statistical procedures as regression, ANOVA, chi-square, and log-likelihood analyses (Zar 1999). Estimates of species diversity, richness and evenness for graduate student thesis projects will derive from customary models (e.g., Shannon-Wiener index, rarefaction, and Pielou's J' – Krebs 1999) to facilitate comparisons among habitats, parks and investigators and at various sample sizes. Statistical analysis will be conducted at Virginia Commonwealth University (VCU). The final report will include, for each park, records of all mammal species and their distributions, relative abundances of species of

concern, survey methods and weather conditions, locations of voucher specimens, and recommendations for long-term monitoring for use by park management.

Project Coordination

Project personnel will include the project director (cooperator), 1 graduate student investigator, and undergraduate assistants. The project director will oversee all activities. Park staff will be notified beforehand by phone or e-mail of all project activities to be undertaken in the park. Monthly schedules, developed in coordination with park management, will be produced by project investigators. Schedules will be adhered to as closely as possible but be subject to change due to weather or unforeseen personnel circumstances; changes in schedule will be communicated in advance by project investigators. The project director will obtain park permits and a state scientific research and collecting permit for conducting the research, collecting specimens, and depositing specimens in the mammal collection at VCU. Investigators (subpermittees) will carry copies of the permits during sampling. In addition, the project director will obtain approval from the Institutional Review Board/Animal Care and Use Committee at VCU. Where park housing is available, project investigators may submit requests for overnight stays when this is necessary for survey work. The project director will negotiate with park management and natural resource personnel any use of park equipment (e.g., GPS) that can facilitate data collection and contribute to the successful completion of the project.

Deliverables

Species data

- Field forms will be provided, upon request, to the NPS I & M Program.
- Digital data sets will be produced in Microsoft Access format, using the NPS I & M template (www1.nature.nps.gov/im/apps/template/) or one specifically developed for the particular project.

GPS data

- GPS coordinates, differentially corrected, will be provided in ArcInfo format or as an ArcView file for all sampling locations and observation sites.

Metadata

- Metadata will be provided in Dataset Catalog format (nonspatial data) or, with the cooperation of NPS data managers, in Federal Geographic Data Committee (FGDC) format (spatial data) found at www.fgdc.gov/metadata/metadata.html.

Voucher specimens

- The mammal collection of the Department of Biology at VCU will be the repository of voucher specimens (Reynolds et al. 1996) and any salvagable individuals encountered in traps or as roadkills. Individuals found dead will be prepared as voucher specimens, either dry skin and skull preparations or fluid preserved whole. Otherwise, voucher specimens of small mammals (shrews, voles, mice and rats) will be obtained from individuals captured live and euthanized by cervical dislocation or thoracic compression (ASM 1998) or selective kill trapping using Museum Special snap traps (Woodstream Corporation, Lititz, Pennsylvania). Specimens of only those species for which no record exists for the park will be sought. Medium- and large-sized mammals will be documented as photo vouchers; photo vouchers or specimen vouchers from trap mortalities, roadkills or individuals found dead; or collection of sign. Threatened and endangered species

will not be sacrificed for voucher specimens; photo documentation will be made where possible and/or hair samples will be collected. Specimens deposited at VCU will be catalogued in the University's database. Whenever possible, tissue samples of salvageable and other catalogued voucher specimens will be taken from the specimens and stored separately in a –80 C freezer.

Reports

- Progress reports will be submitted annually. A draft of the final report will be submitted digitally to the NPS, I & M Program. The final report will be submitted digitally and in hard copy. Any graduate student theses incorporating the work done to comply with the requirements of this agreement will be submitted in hard copy.

Bibliographic citations

- A reprint will be provided for each publication or thesis based on work completed under this agreement.

Project Timetable

Dates to be arranged—but will basically include the items listed below and others as required

Dates

Activities

Submit proposal

Starting date is open, or as per availability of funds for the study and recruitment of a graduate student at the appropriate time

Prepare list of potential species for each of the site as based on published records and principal investigator's experiences with Virginia's mammals

Obtain historical records of mammals for APCO, BOWA, and PETE outline and ground-truth strata and establish sampling sites, establish sampling protocol, design database (template)

Begin survey of mammals at the three areas, refine sampling protocol, establish procedures for data analyses

Prepare progress report

Complete 2nd year survey of mammals at the three sites, compile data; establish procedures for data analyses

Analyze data, prepare progress report

Analyze data, prepare final report (with species data, GPS data, metadata)

BUDGET

I. Personnel assignments and costs

Request from agency

A. Dr. John Pagels' summer stipend - \$7,500/yr. X 2 yrs.	\$15,000
B. Graduate student (all parks) summer stipend \$3,600/su X 2 yrs	7,200
C. Undergraduate assistants 4,500/year X 3	13,500
D. Total personnel	35,700

Fringe Benefits (8.10%)

E. Principal investigator	1,215
Graduate student	583
Undergraduates	1,094
Total Fringe benefits	2,892

I. Total Personnel plus fringe benefits **38,592**

II. Transportation

A. BOWA (roundtrip approx 380 mi) (12 trips @ 380 mi/trip) + (5 mi/trip local travel X 4/trip X 12 trips) = 4800 Mi @ \$0.325/mi	1,560
B. PETE (roundtrip approx 70 mi, combination main Petersburg area and Five Forks, day trips when possible) (35 trips @ 70 mi/trip) + (25 mi/trip local travel X 2/trip X 35 trips) 4200 = mi @ \$0.325/mi	1,365
C. APCO (roundtrip approx 180 mi) (25 trips @ 180 mi/trip) + (15 mi/trip local travel X 4/trip X 25) = 6000 mi @ 0.325/mi	1,950

II. Total Travel **4,875**

III. Lodging

- A. Supplied by NPS. If not, local lodging (or support for it) for approximately 36 nights for BOWA, 20 nights for PTE, and 60 nights for APCO must be found.

Not included in total budget below, but estimate (for 116 nights at \$30.00) is \$3480

IV. Equipment, supplies, etc.

A. Sherman live traps – 100 @ \$14.00 + \$50 shipping	\$1,450
B. Tomahawk single-door, collapsible (squirrel size) – 30 @ \$40.00	1,200
C. Tomahawk single-door, collapsible (raccoon size) - 10 @ 70.00	700
D. Tomahawk single-door, collapsible (bobcat size) - 5 @ 170	850
E. Pesola scales (3 ea. 30-g and 100-g, 1 ea. 10-g and 600-g)	259
F. 5 silt fences (for pitfall arrays); 2' X 100' @ \$18.00	90
G. Rabies vaccine – (4 series @ \$120)	480
H. Night-vision binoculars	900
I. TrailMaster TM 1500 Active IR trail monitor – 2 @ 260	520
J. TrailMaster TM 35-1 Camera Kit 2 @ \$290	580
K. TrailMaster TM Data Collector – 2 @ \$250	500
L. SONY MVC-CD 1000CD Mavica digital camera	1,000
M. 3 Nokia 5185i cell phones @ \$100	300
N. Dell Inspiron 2100 notebook computer with 20 GB hard drive, 256 MB RAM, and extra battery	2,150
O. Miscellaneous supplies (flagging, bait, stakes, sampling bags, specimen preparation supplies, map acquisition, ear tags, applicators, computer supplies, rain/water proof photocopy paper, field gear, ice, photocopying, film, head lamps, batteries etc.)	950
P. Professional meetings, attendance and paper presentation @ \$1,000/yr. for 2 yrs.	2,000

IV. TOTAL **\$13,929**

Project Subtotal **\$57,396**

Indirect costs (20 %) **\$11,479**

PROJECT TOTAL **\$68,875**

VCU's Match

I. Graduate teaching assistantship @ \$10,844/yr for 2 yrs	\$21,688
II. Tuition waiver for graduate student @ \$4,112 in-state student, (12,185 out-of-state 2 yrs = \$16,146 more)	8,224 (16,146)
III. Pagels salary, academic year and summer, @ \$7,500/yr for 2 yrs	15,000
IV. Remainder of mandated 45% indirect costs from federal agencies (25% of 57,396)	14,349

VCU's total match

\$59,261
(\$67,183)

Additional VCU support of the project: Use of VCU vehicle when available, modern laboratory, equipment, supplies, and additional support (traps, GPS unit, compasses, measuring tapes, Pesola scales, binoculars, aerial photo stereoscope, specimen storage and maintenance, graduate faculty support, secretarial and fiscal technician support, photocopying and duplicating services, mail, etc) = Approx \$20,000, cannot use as official match)

Budget Justification

<u>Item #</u>	<u>Justification</u>
I. A	Support for the project director (principal investigator) for 1/2 summer salary for 2years for project coordination, field work, data analysis, report preparation, etc.
I. B, C, D	One graduate student and three undergraduate student assistants will be needed to conduct the proposed work within the proposed period. Support in the amount of a stipend for two summers is requested for the graduate student. VCU will provide a teaching assistantship to the student for 2 years. I
I. E	VCU requires payment of fringe benefits for salaries
II.	Based on best estimates of mileage and trips needed to complete project
III.	If NPS lodging is not available, NPS support for such will be sought.
IV. A, B	Traps needed for simultaneous trapping of small mammals at 3 national parks
IV. C, D	Traps needed for simultaneous trapping of medium-sized mammals at 3 national park
IV. E	Scales needed to do work at more than one site, replace damaged etc
IV. F	Needed to construct drift fences for pitfall arrays for capture of shrews and select other small mammals at 3 national parks
IV. G	Required for principal investigator and 3 students
IV. H	For night-time observation and detection of medium and large mammals
IV. H, I, J, K	Remote detection units and cameras needed for documentation of larger, secretive and elusive mammals
IV. L	Camera needed for voucher specimens, confirmation of identifications of amphibians and reptiles in pitfall traps, etc.
IV. M	Needed for safety and convenience of students who will be in the field simultaneously
IV. N	Note book computer needed for compilation, manipulation, and storage of species and other field data—notably when in field/on the road. Also may be used for integration, analysis of species data, GPS data, metadata, and field data
IV. O	Self-explanatory
IV. P	Travel, registration, lodging, and meals for graduate students and project director for 2 yrs.

Project 4 Avian Species Inventories at BOWA, PETE, APCO, RICH, FRSP

Total \$61,920 (2003 request)

Pre-Proposal

Title: Inventory of avian species within National Parks of the Mid-Atlantic Network

Investigator: Center for Conservation Biology, Department of Biology, College of William and Mary

Project Contact: Bryan D. Watts, Ph.D.

BACKGROUND: In 1991, the National Park Service published its plan to protect natural and cultural resources within service lands. Among other things, the plan calls for park managers and superintendents to have access to solid information about natural resources occurring on lands under their direction. The plan points out that reliable scientific information is central to maintaining ecosystem integrity. The Natural Resource Inventory and Monitoring Program that emerged from this plan is centered around five long-term goals. The first of these goals is to complete baseline inventories of natural resources.

On April 3, 2001, representatives of seven parks within the Mid-Atlantic Network and three parks within the Coastal and Barrier Network along with numerous experts on various taxonomic groups met at the Richmond Battlefield Park to develop plans for park inventories. The status of inventory materials was discussed for individual parks. The status of bird information varied considerably between parks from no information to nearly complete information.

The purpose of this project is to complete avian inventories for the five parks included in the Mid-Atlantic Network. These parks include Petersburg National Battlefield, Richmond National Battlefield Park, Fredericksburg & Spotsylvania Battlefields, Appomattox Court House National Historical Park, and Booker T. Washington National Monument.

OBJECTIVES: There are three interrelated objectives of the inventory and monitoring program. These include

1. Document through existing data or targeted fieldwork, at least 90% of the predicted species of birds currently estimated to occur on park lands.
2. Describe the distribution and relative abundance of species of special concern, such as Threatened and Endangered species, exotic and other species of special management interest occurring within park boundaries.
3. Provide the baseline information needed to develop a general monitoring strategy and design that can be implemented by parks once inventories have been completed.

Proposed project phases and their respective objectives are listed below.

Phase 1: Information Mining

Objective 1) Search for and catalog all verifiable records of birds occurring within boundaries of each park.

A search will be made of existing published and gray literature for records of birds observed or collected within the boundaries of focal parks. A request will be sent out to the bird watching community to request documented occurrences from personal records.

Objective 2) Utilize available information resources to develop an “expected” list of species for each park. Range maps, atlas data, and other information resources will be used to develop an expected list of birds for each park. Staff members within the Center for Conservation Biology have conducted extensive research throughout virtually every habitat within the mid-Atlantic region. This expertise will be used to develop lists of expected species by habitat.

Phase 2: Prepare for Park Inventories

Objective 1) Delineate habitats within parks for targeted surveys.

Because many bird species exhibit high affinities for specific habitats, it is important that all available habitats be surveyed within each park. Aerial photography will be used along with park resources to delineate patches of existing habitats. These habitats will be used to refine the inventory plan for each park.

Objective 2) Develop an inventory plan for each park.

An inventory plan will be developed for each park independently. This plan will reflect target species, available area, habitats, and accessibility. A common survey approach/methodology will be used for all parks surveyed.

Objective 3) Assemble a volunteer pool to survey accessible portions of parks.

An attempt will be made to assemble a volunteer pool from the bird-watching community. It is likely that some incentives (e.g. free access to parks, access to parks during off hours) will need to be offered to attract a pool large enough to conduct needed surveys. A notice will be sent out through various outlets to solicit volunteers.

Phase 3: Conduct Inventory of Birds within each Park

Objective 1) Coordinate volunteer effort to survey accessible areas.

In order to collect worthwhile information, volunteers will need to be educated about field methods. Volunteers will also need to be directed to where effort is needed according to the inventor plan. It is likely that mailings will need to be prepared or a web site will have to be created to provide volunteers with adequate information.

Objective 2) Conduct surveys to fill spatial and temporal gaps in coverage.

It is unlikely that a volunteer pool of observers could be assembled that would cover all survey needs. It will be necessary for project personnel to conduct surveys that are not covered by volunteer bird watchers. These include both time periods when volunteers are not available and/or locations where volunteers are not available or not permitted.

Phase 4: Prepare and Submit Inventory Results

Objective 1) Catalog and prepare information to meet product specification standards for NPS Inventory and Management Program.

The NPS Inventory and Management Program has a standardized list of specifications for information documentation and submission. Personnel will work to manage information in a manner the conforms to these specifications.

Objective 2) Prepare and submit final inventory report.

A final report will be prepared and submitted that presents all inventory findings.

SCOPE OF SERVICE: The Center for Conservation Biology will coordinate and conduct all aspects of the inventory of birds on the parks listed within the mid-Atlantic Network. Results of the inventory will be reported in a manner consistent with the specifications outlined in the National Park Service Product Specifications document.

BUDGET AND NARRATIVE

Budget Category	Requested Funds
A. Personnel	
Salary	\$35,000
B. Fringe Benefits	\$10,500
C. Travel	\$2,880
D. Lodging	\$600
E. Equipment	0
F. Supplies	\$620
G. Construction	0
H. Other	\$2,000
I. Total Direct Cost	
Costs (a-h)	\$51,600
J. Indirect Cost	\$10,320
K. Total Cost	\$61,920

BUDGET NARRATIVE

- A. This project will require 1 coordinator to work with volunteers, develop survey approaches, manage information and report inventory findings. An estimated 12 months of work will be required to complete project objectives. This will be a full-time position with benefits.
- B. Fringe Benefits for coordinator calculated as 27% of salary.
- C. Mileage for projects estimated to be nearly 9,000 miles (\$0.32/mi).

D. Estimated lodging includes 12 overnight stays (\$50/night).

F. Office supplies, copying and other misc. costs estimated to be \$620.

H. Costs to create a website to coordinate volunteer efforts estimated to be \$2,000.

J. Indirect cost figure represents the ONR – negotiated indirect cost rate (45%) less indirect cost funds waived by the college (\$23,220 – \$12,900).

Project 5 Herp Reconnaissance at BOWA, PETE, APCO, RICH, FRSP

Total \$4,774 (2002 request)

Pre-Proposal

Title: Reconnaissance of Five National Parks in VA

Principal Investigator: Joseph C. Mitchell, Ph.D., Department of Biology, University of Richmond

Introduction

Most of the national parks in Virginia have not been well surveyed for amphibians and reptiles. Shenandoah National Park has received some attention in the past, largely through the collection of museum specimens. An ongoing study has already assembled most of these data and is currently conducting field surveys. Jamestown Island (part of COLO) is being surveyed in 2001 (compliance with NEPA regulations for activities associated with the 2007 celebration). Three additional parks (Manassas, George Washington Memorial Parkway, Wolf Trap) are included in the project just funded through the National Capital Parks network. The remaining national parks in Virginia (Fredericksburg, Richmond, and Petersburg battlefields, Appomattox Court House, and Booker T. Washington National Monument) have not been inventoried for these taxa and there is no proposal currently pending.

Objectives

The primary objective of this reconnaissance project is to obtain information on each of the five national parks named above that will allow a more-informed estimation of the costs to conduct a amphibian and reptile inventories on these parks.

Study Area

Each of the five national parks (Fredericksburg, Richmond, and Petersburg battlefields, Appomattox Court House, and Booker T. Washington National Monument) will be evaluated in this reconnaissance.

Methods

Each park will be visited on one day during which I will meet the resource manager, evaluate available maps, and conduct a windshield and hiking survey of the park. During this survey I will summarize park size, determine the primary habitat types present and their distribution, obtain notes on wetlands present (noting for example numbers of vernal pools, beaver ponds, and impoundments), and evaluate available information on file in the park.

Deliverables

The product of this reconnaissance will be a brief summary of size, habitats present and their distribution, types of wetlands present, and a list of possible species. This summary will be incorporated or

attached to a future proposal to the NPS I&M program for funds to conduct the amphibian and reptile inventories.

Budget

Salary for PI	\$4000.00
Fringe	\$340.00
Indirect costs (10%)	\$434.00

<u>Total</u>	<u>\$4774.00</u>
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Project 6 Herp Inventory at BOWA, PETE, APCO, RICH, FRSP

Estimate \$81,718 (2004 request)

Description: Proposal will be submitted once Project 4 is complete.

Project 7 VADGIF Fish Database Search BOWA, PETE, APCO, RICH, FRSP, SHEN

No Funds Requested

Title: Identifying the gaps in Fish Inventories in the VA Mid-Atlantic parks.

Description-The Virginia Department of Game and Inland Fisheries (VDGIF) has developed a system of wildlife databases that are available online. The databases offer species information and geographic search capabilities. The VDGIF database contains records reported by scientific researchers and agency biologists, statewide surveys of fish, birds, and herps, a colonial bird survey, federal and state bird monitoring databases, statewide surveys of coldwater streams, including trout streams, and surveys of warmwater streams, springs, impediments to anadromous fish migration and more.

Personnel from the department of VDGIF have volunteered to search the database for records on fish collected in the six parks. This information will then be reviewed by staff fisheries biologists who will identify gaps in fish inventories in each of the parks. Staff from RICH have offered to take this information and contact the state fisheries biologists within the regional offices to complete inventories where needed.

*Note-The database search began in September, 2001 by VDGIF staff and should be completed within one month.

INVENTORY GOAL 3

To determine the distribution and abundance of target groups of vertebrate and vascular plant species identified by the Network.

Project 8 Bat Inventories at EISE, GETT, HOFU, VAFO

Estimate \$10,000 (2003 request)

Title: Bat Inventories in the PA Mid-Atlantic parks.

Description: RFP in preparation. The money requested here will be used to do bat reconnaissance in these four parks. Once this is determined, funding from other sources will be sought for a complete inventory. Bert Frost from GETT is in the process of putting together a scope of work for this project. This will be a combined effort with four PA parks from the Eastern Rivers and Mountains Network. The cooperators working on bats in the West Virginia parks in that Network may be approached about cooperating on this project as well.

SECTION VI-PRODUCT SPECIFICATIONS

Product specifications are being developed for the Northeast Region I&M Program (Appendix B). The following is a list of deliverables that will be required of all cooperators and contractors working in the Mid-Atlantic Network as part of the I&M Program. Research taking place in the parks, independent of the funding source, will also be required to provide these products at the end of each project.

1. Species Data

Raw Data

Copies of all raw data, such as hand written field forms (if used), must be provided if requested by the Network.

Species Inventory Database

All inventory data will be provided in an MS Access database. Database templates being developed by WASO for inventory and monitoring data will be required and used by the Network.

2. GPS Data

Cooperators must provide GPS coordinates and attributes (e.g. location ID, description, and habitat classification) for all fixed sampling locations (e.g. plots, transects, etc...). Cooperators are also encouraged to obtain GPS coordinates and attributes for observations obtained from general search areas or opportunistic sightings, but are not required to do so. GPS data must be differentially corrected with base station files. The data should be supplied as an ArcInfo coverage or as an ArcView shapefile in the coordinate system currently in use at the park. For most parks, this will be the correct UTM zone in which the park is found. The datum should be the North American Datum of 1983 (NAD83); the ellipsoid should be the Geodetic Reference System 80 (GRS80); and units of measure should be meters. Please review the GPS standard operating procedures for field data collection and the spatial data format requirements in the Appendix (Sections II& III).

3. Metadata

Non-spatial digital data

Metadata must be provided in NPS Dataset Catalog format for each non-spatial digital data set produced.

Spatial digital data

Cooperators must provide metadata for each spatial digital data set (e.g. GPS coverage of fixed sampling locations) produced. All metadata must follow Federal Geographic Data Committee (FGDC) compliance standards.

4. Voucher Specimens

The Mid-Atlantic Network chooses to leave the issue of vouchering up to the discretion of the park where the inventory is taking place. An agreement on vouchering must be reached prior to beginning the inventory.

5. Reports

Progress Reports

Progress reports must be submitted digitally in Word format, and as paper copy if requested. Minimally, they will be due annually dependent upon the length and scope of the project.

Final Reports

The final report will be submitted digitally as draft in MS Word, and as paper copy, to the Regional I&M or Network Coordinator for management and scientific review and comment. It must include methodology, analysis, results and discussion. The final report will be submitted in digital and paper copy formats. Because the final report will be made available on an NPS website, it must be submitted both as 1) a Word 6.0 or higher

version document (.doc) in its entirety on diskette or CD-ROM, and 2) a Word 6.0 or higher version document (.doc) containing all text and tables, and individual Tiff documents (.tif) for each graphic image contained in the report on that same diskette or CD-ROM.

6.1 Voucher Specimen Collection

A repository for specimens collected during inventory work in the Mid-Atlantic Network parks has not yet been identified. At this time, any specimens collected will be housed at the cooperating University or associated institution. The final decision on the collection of voucher specimens will be left up to the discretion of each park, but the collections policy for the Northeast Region I&M Program is as follows. **Cooperators may collect whole specimen vouchers** on amphibians, snakes, mammals, fish and plants **only if**:

1. **Identification of a species is in question.** Certain taxa such as fish may require more intensive vouchering than other taxa such as mammals.
2. **Or if a particular species has not yet been collected in a park.** A list of existing voucher specimens will be available for each park, and cooperators are required to review this list prior to fieldwork.

Plants and animals that **may not** be whole-specimen vouchered include birds, turtles, large mammals and common plant species. If vouchering is necessary for identification purposes, then photo documentation is required.

Photo Documentation

The Mid-Atlantic Network is requiring all cooperators to use non-invasive methods of vouchering, such as hardcopy color photography, high quality digital photography or animal signs or remains (e.g. hair samples, scat or tracks) whenever possible. Photographs of a species will be considered a voucher and will be referenced in NPSpecies. Photographs taken to provide documentation of a species must be taken with a macro or close-up lens. Photographs should show known features used for identification of a species. It may be necessary to take more than one photograph of an individual from different angles. All photographs must be submitted with the pertinent raw data. All slides and photographs must be kept in appropriate protective sleeves.

Whole Specimens

Collectors will be responsible for cataloging specimen/field notes for items deposited into non-NPS repositories. The more information a collector can provide, the more useful the specimen/field notes will be to future managers and researchers.

Voucher preparation will be the responsibility of the cooperator who must have a valid park permit to collect specimens. All vouchers taken on NPS lands, regardless of their repository, will be the property of the NPS. Cooperators will be responsible for accessioning voucher specimens into ANCS+.

Voucher specimen collection must follow the guidelines defined by the Components of British Columbia's Biodiversity (CBCB) manual #4, Collection and Preparation of Voucher Specimens and any guidelines a cooperating institution's Animal, Care and Use Committee has developed.

Mammalian Collection

In order to minimize disturbance on mammalian populations in the parks, photo vouchering and collecting animals where death resulted from either trap mortality or road kill will be priority over euthanizing individuals. Vouchering methods are described in Table 1 for some mammalian groups that may be found in northeastern parks. Guidelines found in the *Live Animal Capture and Handling Guidelines*, manual no.3, will be followed for proper capture, handling and euthanasia procedures. Guidelines and references for the preservation of voucher specimens can be found in *Measuring and Monitoring Biological Diversity, Standard Methods for Mammals* (Wilson et al, 1996).

Table 1. Vouchering methods for some mammalian groups.

Taxa	Vouchering Method
Bats	Wing punch or whole specimens for easily misidentified species when capture is part of the inventory protocol. Morphometric data, photographs, digital sonograms or cassette tapes with reference calls should also be collected as evidence of rare or endangered bats.
Small Mammals - Shrews, Voles, Mice, Rats and Lemming	Three of each species: 1 of each sex (if sexes are distinguishable) and the 3rd a juvenile (of either sex) is preferred, especially if there is much difference from the adults.
Moles	Whole specimens only if trap mortality occurs.
Medium-sized mammals	Photo vouchers or specimen voucher from trap mortality and road kill, collection of other sign when possible (tracks, hair, scat).
Large mammals	Photo vouchers, collection of other sign when possible (tracks, hair, scat)

Fish Collection

Digital photographs can be an accurate and economical method for vouchering fish specimens. The Network will follow the guidelines for vouchering fish specimens by Dr. Jay Stauffer and Timothy Stecko from Penn State University (**Appendix ????**). Although it may not be possible to identify all fish specimens from digital photographs taken in the field, these guidelines will be useful for most fish collected. Immature fishes of all species and some of the minnow species, particularly in the genus *Notropis*, need to be collected and properly preserved.

Amphibian and Reptile Collection

For identification purposes, most species of amphibians and reptiles can be adequately confirmed from photographs. Collecting whole specimens of amphibians and snakes will only be allowed as stated above, if a whole specimen does not exist for a park. Turtles must be photo documented only.

Vascular Plant Collection

Species that are common to the park or have already been vouchered should not be collected. Because any collection of specimens impacts a population, it is especially important when collecting rare species to weigh the destructiveness of collection against the amount of information gained. Federal and state Threatened and Endangered plants will not be collected in populations of less than 50 individuals (Elzinga et. al, 1998). It is incumbent upon the cooperator to know which taxa are locally or nationally rare or protected, and to be familiar with all federal and state legal procedures for collecting. In small populations, only small portions of plants will be collected if necessary. Cooperators are advised not collect indiscriminately, even in large populations, and to collect only the minimum amount of plant material necessary. (The Plant Conservation Round Table, 1986).

Voucher specimens will be collected during inventory in accordance with collections policies outlined in *NPS Management Policies* ("Museum Objects and Library Materials" and "Preservation of Data and Collections and Protection of Research Potential") and NPS-77, *Natural Resource Management Guideline*. Obtaining the necessary permits for collecting will be the responsibility of the cooperator/contractor and the parks.

For all voucher specimens, cooperators will be asked to fill in the information below and submit information as an Appendix with their final report. This information will enable the park to fully document their research in the National Park Service's National Catalog as well as the NPSpecies database.

BIOLOGICAL SPECIMENS:

- Collection Permit number: _____
- Fixative or killing agent used: _____
- Preservative agent used: _____
- Number of specimens: _____
- Order: _____, Genus _____, Species: _____
- UTM, Latitude/ Longitude, or elevation where collected: _____
- Collection Site: _____
- _____
- Principle Investigator: _____
- Specimen Identified (classified) by: _____
- Collection Date: _____

6.2 Compliance

The Mid-Atlantic Network will incorporate compliance with park and regional research and collection policies, the National Historic Preservation Act (NHPA), Section 106, and the National Environmental Policy Act (NEPA) throughout the implementation, and reporting phases of its biological inventories.

Individual parks within the Network have specific permitting requirements that will be outlined in the Statement of Work for each contract. At a minimum, each researcher will be required to obtain a park Collection Permit and must submit an Investigator's Annual Report upon completion of each inventory.

Documentation of study plan approval from the Fish and Wildlife Service (FWS) will be required for those projects with the potential to effect federally listed T&E species.

SECTION VII DATA MANAGEMENT

As the Inventory and Monitoring Program develops and years pass, not only will there be data existing for the nine parks in the Network, but there will be data collected by different biologists, scientists, and technicians, that will consist of unavoidable variation. In order to reduce such variation, and to ensure the reliability and usability of the information gathered, the Mid-Atlantic Network will develop a data management plan that provides sufficient standards for managing such data. An information management system will set the foundation for obtaining consistent end products among studies, and provide for the documentation of all efforts and results in a consistent and comprehensive manner. Sufficient effort must go into the planning and design phase of creating a workable data management plan that will continue to be used throughout the Network's long-term monitoring program. Data management is a high priority for the Network. The Network has and is in the process of converting all of the relevant existing data into NPSpecies and into relational databases as discussed in this plan. A full-time term data manager position will be filled to coordinate and manage both legacy and newly acquired data for the network. This position will work closely with other NPS staff at the network, region and service-wide level to meet the data management goals in the most efficient and cost effective way possible.

There has been a great deal of effort by WASO I&M to develop tools for managing inventory and monitoring data which includes digital, bibliographic and spatial information, and excellent guidance is provided in the data management protocols (NPS 1996). The I&M Database Templates developed by the Servicewide I&M Program will be used to help the Network develop a relational database that is compatible with the GIS Theme Manager. The MID-ATLANTIC Network plans to build on these available resources and as discussed in the Heartland Network's Inventory Plan, this Network will emphasize the role of data management in the course of data collection and handling.

The minimum standards that will be required of contractors and cooperators will include(Northeast Region Product Specs, Appendix B):

- Standardized collection and data entry methods

- Software requirements
- Standardized data fields dependent upon the Database Template Data Dictionary
- Data verification and validation requirements
- Metadata requirements

Network Objectives Include:

1. Identifying the data backlog for the Network and complete the entry of this material into the appropriate databases, NPSpecies database, the Dataset Catalog, NRBIB or GIS.
2. Provide a data management framework and methodology for current field collections, which will include protocols for both spatial and nonspatial data collection and handling.
3. Ensure FGDC compliant metadata for all information.
4. Identify partnerships and common strategies for data collection and management.

7.1 Data Collection

The MID-ATLANTIC Network will require the use of standardized field forms that contain standardized locations and events codes as well as habitat measures for all inventory and monitoring projects. Field activities are to be well documented by requiring all investigators to document their standard operating procedures used during the course of their study. This will include a step-by-step description of the procedures used to collect data, including any modifications or adjustments made to accommodate field conditions, the precision of instruments, etc... All raw data collected during the biological inventories, as well as all summary products produced will be entered and/or cataloged into the appropriate service-wide product on an annual basis.

7.2 Data Verification

All principle investigators are expected to verify their data 100% before submitting it to the Network. The Network will require copies of all field data sheets from cooperators and sub-samples of the data will be compared with the associated field data sheets. A minimum of 95% accuracy will be expected.

7.3 Data Formats

Non-Spatial Data

All non-spatial inventory data must be submitted to the Network in MS Access database format. The Network Data Manager will begin developing a relational database for the Network that will be based on the NPS I&M Database Template being developed by WASO. The Network database will be provided to all investigators along with standardized field forms, before field work begins. The NPS I&M Database Template will be the final product for newly acquired data from field surveys to facilitate it's linking to the GIS Theme Manager.

GIS Data

Spatial data, which include GPS generated files, must conform to the following guidelines:

Projection and Coordinate System

All digital geospatial data should reference the coordinate system corresponding to the standard presently in use at the park which, for most parks, will be the correct UTM zone in which the park is found. The datum should be the North American Datum of 1983 (NAD83); the ellipsoid should be the Geodetic Reference System 80 (GRS80); and the units of measure should be meters. The contractor should contact the park's GIS Coordinator for specific instructions and/or refer to the contract or cooperative agreement.

Scale and Spatial Resolution (Vector Data)

New data should not exceed 1:24,000. The contractor should contact the park's GIS Coordinator for specific scale and spatial resolution requirements for vector data or they may be specified in the contract or cooperative agreement.

Scale and Spatial Resolution (Image Data-digital or aerial photography)

The contractor should contact the park's GIS Coordinator for specific scale and spatial resolution requirements for image data or they may be specified in the contract or cooperative agreement.

For vegetation classification under the NPS/USGS vegetation classification project, the current standard is 1:12,000 color infrared aerial photographs with 60% overlap and 30% sidelap.

Horizontal and Vertical Accuracy

All data should meet or exceed the following National Map Accuracy standards (Source: USGS Fact Sheet 078-96, September 1997).

For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as benchmarks, property boundary monuments; intersections of roads and railroads; corners of large buildings or structures (or center points of small buildings). In general, what is well-defined will also be determined by what is plottable on the scale of the map within 1/100 inch. Thus, while the intersection of two roads or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. This class would cover timber lines and soil boundaries.

Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error by more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

The following table provides the allowable horizontal accuracy for some common scales:

<u>Scale</u>	<u>Allowable error (feet)</u>
1:40,000	111
1:24,000	40
1:20,000	33
1:12,000	20
1:9,600	16
1:4,800	8
1:2,400	4
1:1,200	2

Attribute Accuracy

At a minimum, an 80% or greater overall thematic attribute accuracy at the 90% confidence interval is required. The contractor should contact the park's GIS Coordinator for specific attribute accuracy requirements or they may be specified in the contract or cooperative agreement.

Spatial Data Formats

At a minimum, all vector data is to be supplied as an ArcInfo coverage and ArcInfo interchange file, e00, compatible with the current version of ArcInfo for the MS Windows operating system. All raster data is to be supplied as an ArcInfo GRID and ArcInfo interchange file, compatible with the current version of ArcInfo for the MS Windows operating system. All digital imagery, such as scanned aerial photographs, is to be supplied as tagged image file format (tiff) files with the proper header file for geo-referencing purposes. The contractor should contact the park's GIS Coordinator for specific data formats or they may be specified in the contract or cooperative agreement. All data should be delivered on CD ROMs compatible with the MS Windows operating system.

Quality Control

When the contractor has completed 10% of the spatial and attribute data development, the contractor must supply the data to the park and appropriate Regional Technical Support Center (RTSC) for quality control purposes. The data must be delivered in conformance to the Spatial Data Formats requirements. Once the park and RTSC have checked the data and found it acceptable, the contractor may continue data development. Once the contractor has completed the work, the park and RTSC must accept the spatial data, attribute data, and Federal Geographic Data Committee (FGDC) compliant metadata before the job is considered complete.

Results of tests used to verify all applicable horizontal, vertical and attribute accuracy measurements should also be provided whenever data is provided to the park and RTSC.

7.4 Metadata

All digital geospatial data must have FGDC compliant metadata in digital form developed by the data producer. The metadata should be parsed using the metadata parser provided by the FDGC (<http://www.fgdc.gov>). The

metadata should be supplied as ASCII text with a txt extension, hypertext markup language with an html extension and standard general markup language with an sgml extension. The contractor should contact the park's GIS Coordinator or the appropriate RTSC for metadata development instructions.

All digital non-spatial data must be provided to the Network with a digitally completed Dataset Catalog form.

7.5 Data Cataloging

All products cataloged into the NPS service-wide NRBib or Dataset Catalog databases will be archived for future acquisition. Hardcopy products will be stored in file cabinets, shelves or other appropriate structures. Digital products will be copied to CD-ROM and appropriately stored as well. The exact local of archived products has yet to be determined and may occur at the park, network, region (or support office), and/or service-wide level. The copies will be appropriately organized to facilitate future acquisition. Each entry in NRBib or the Dataset Catalog will include the physical location of each product. Conversely, each stored product will be marked with the unique identifying code assigned in the database. On an annual basis, at a minimum, final MS Access files will be stored on CD-ROM, copied, and stored in separate locals. The copies will be appropriately organized to facilitate future acquisition. An entry will be made in the NPS Dataset Catalog for each database file (or files) that includes the physical storage location of the CD. The Dataset Catalog Identification code (or codes if multiple files are stored on one CD) will be marked on each stored copy.

SECTION VIII-STAFFING AND SUPPORT

8.1 Staffing

I&M Program Support

The Northeast Region I&M Coordinator will provide technical assistance with contracting and cooperative agreements for the Mid-Atlantic Network. She will oversee and assist the Network and provide guidance in completing the inventory initiative in these parks.

The Northeast Region I&M Program assistant, will continue to act (one quarter of the time for this Network) as a liaison between contractors/cooperators during the inventory process, provide park representatives with updated information about the program and continue to gather existing information for the network parks through local agencies/programs.

8.2 Partnerships

University of Rhode Island-Cooperative Agreement

- Data Management Support
- I&M Program Regional Coordinator (duty station)
- Northeast Region I&M Program Research Associate

Penn State University-Cooperative Agreement

- NRBIB Specialist-Research Associate
- Collections Search for Fish Specimens-Dr. Jay Stauffer (NY, NJ, PA, VA, WV, MD)
- NPSpecies/Dataset Catalog/GIS Theme Manager-Research Associate
- Comprehensive Inventory Program for Birds at Six Pennsylvania National Parks: Phase II.-Dr. Richard Yahner (GETT, EISE, HOFU, VAFO).
- Inventory of Amphibian and Reptile Species-Dr. Richard Yahner (GETT and EISE).

Frostburg University CESU -Cooperative Agreement

- Mammal Inventory-Dr. Ron Barry (FRSP, RICH)

Virginia Commonwealth University -Cooperative Agreement

- Mammal Inventory-Dr. John Pagels (BOWA, PETE, APCO)

University of Richmond -Cooperative Agreement

- Herpetological Reconnaissance-Dr. Joseph Mitchell (RICH, FRSP, BOWA, PETE, APCO)
- Herpetological Inventory- Dr. Joseph Mitchell (RICH, FRSP, BOWA, PETE, APCO)

College of William and Mary-Cooperative Agreement

- Avian Inventories-Dr. Bryan Watts (RICH, FRSP, BOWA, PETE, APCO)

West Chester University of PA-Cooperative Agreement

- Herpetological Inventories -Dr. Harry Tiebout (HOFU, VAFO)

VA Natural Heritage Program-Cooperative Agreement

- Vegetation Mapping Plot Data/vascular plant inventory –Chris Ludwig (RICH, FRSP, BOWA, PETE, APCO)

North Carolina State University-Cooperative Agreement

- Vegetation Mapping–Dr. Hugh Devine (RICH, FRSP, BOWA, PETE, APCO)
- Mid-Atlantic Network Dataset Catalog

The Association for Biodiversity Information-Cooperative Agreement

- Development of vegetation keys to the association level: tools to facilitate vegetation mapping, inventories and sampling–Lesley Sneddon (All Mid-Atlantic Network Parks).
- Plot sampling to National Vegetation Classification System (NVCS) (RICH, FRSP, BOWA, PETE, APCO, VAFO)

SECTION IX-THE BUDGET

9.1 Meeting the Goals of the Network's Pre-proposal

The following is a list of tasks described in the Mid-Atlantic Network Inventory Program pre-proposal and now completed or ongoing with funding that was allocated to the network FY 2000-2001 (Table 8) (Preproposal, Appendix D).

- **NPSpecies Database**–A research associate was hired through a cooperative agreement with Penn. State University to work on the development and clean up of the NPSpecies database for the network (March 2000-Dec 2000, full-time again beginning May 2001-2002). This is a shared position between the Mid-Atlantic, the Eastern Rivers and Mountains, and Coastal and Barrier Network. This position will also be searching, gathering and entering specimen information for the network parks from regional museum collections.
- **NRBIB**–A research associate was hired through a cooperative agreement with Penn. State University to update the NRBIB for all of the parks in the network. This is a shared position among all four Northeast Region Networks.
- **Dataset Catalog**–North Carolina State University was hired to create a Dataset Catalog for spatial data sets for the Mid-Atlantic Network. NC State has been working to convert FGDC metadata to the Dataset Catalog.
- **Scoping Workshops**–A scoping workshop was held for the Mid-Atlantic Network VA parks in April 2001 at RICH and a workshop was held in November 1999 and again in June 2001 for the PA parks at Penn State University.
- **Full Study Plan**–A research associate was hired (2000-2002) through a cooperative agreement with the University of Rhode Island to act as the Northeast Region I&M Program Assistant to; help organize scoping workshops, write the scoping reports, gather existing information for the parks, and develop and write full study plans for the regional networks, including the Mid-Atlantic Network.

Table 8. Projects funded by Mid-Atlantic Network I&M Program funds requested in the pre-proposal (FY00-\$65,000).

Project	FY 00	Cooperator
Update NRBIB*	\$11,250	Penn State-Scott Tiffney (Cost share with 4 networks)
URI (Research Associate)*	\$10,690	University of Rhode Island (Cost share w/4 networks)
Dataset Catalog development*	\$2,000	North Carolina State University (NCS)
SubTotal	\$23,940	
	FY 01	
URI (Research Associate)*	\$23,642	University of Rhode Island (Cost share w/ 4 networks)
NPSpecies (Research associate)*	\$10,000	Penn State Univ. (cost share w/2.5 Networks)
Shenandoah Database Clean up	\$4,200	
Dataset Catalog	\$2,000	NC State University
Scoping Workshops (travel, other)*	\$2,500	VA and PA workshops
SubTotal	\$42,342	
Total	\$66,282**	

*Requested in pre-proposal

**\$1,282 over budget-will request in FY02 budget.

Table 9. Mid-Atlantic Network Inventory Projects funded by sources other than designated I&M Network Funding (FY00-FY01).

Projects	Amount	Source	Cooperator
Avian Inventories at GETT, EISE, HOFU, and VAFO.	\$346,403	Continuation of previously funded studies (I&M)	Penn State University-Dr. Richard Yahner
Inventory of Inverts, Amphibian and Reptile Species at GETT and EISE.	\$40,671	I&M (pre-network)	Penn State University (KC Kim and Dr. R. Yahner)
	\$138,000	Park base	
Inventory of Amphibian and Reptile Species at HOFU and VAFO.	\$79,446	I&M (pre-network)	West Chester University of PA (Dr. Harry Tiebout III)
Inventory of Amphibian and Reptile Species at HOFU	\$20,072	I&M (pre-network)	West Chester University of PA (Dr. Harry Tiebout III)
Fish Voucher Search (Shared by 4 Networks)	\$33,966	Regional Science (FY)	Penn State University-Dr. Jay Stauffer
Amphibian Inventory (SHEN)	\$78,000	Prime Net	Univ. of Richmond (Dr. Joe Mitchell)
APPA NRBib	\$40,000		Penn State University
Vegetation Mapping (2001) (RICH, FRSP, PETE, BOWA, APCO) APCO Veg Map	\$60,665	Vegetation Mapping Program/Fire Program/ Fee Demo/park base	NC State (Formation level map)
	\$21,825	Veg Mapping/Fire Program	Kucera, In'tl (photography)
	\$11,500	FT. Lee/USDOD	
	\$109,582	Veg Mapping Program	VADNH (Veg Plots, alliance map)
	\$15,359	Regional Science Funds	ABI (Crosswalk to NVCS)
	\$20,000	Park planning funds	NC State (Formation level map)
Vegetation Mapping (SHEN)	\$70,000	Fire Program	ABI
	\$295,000	NRPP	USGS
	\$115,000	Fee Demo	VADNH/SHEN Fire Mgt/Park staff
Vegetation Key Development for NE Region	\$50,818	Veg Mapping Program	ABI/USFWS cost share
Total	\$1,546,307.		

9.2 Mid-Atlantic Network Inventory Plan Budget

The total funds to be provided to the Network for vertebrate and vascular plant inventories is \$424,635, \$65,000 of this was allocated in FY00. (Note-The Network went over budget by \$1,282 in FY00, this amount is requested in the FY02 budget).

Table 10. Mid-Atlantic Inventory Plan Budget.

Budget Item	FY02	FY03	FY04	FY05
Inventory costs				
Baseline Bat Inventory (4 PA parks)		\$10,000*		
Birds (baseline inventory 5 VA parks)		\$61,920		
Mammals (baseline inventory 2 VA parks)		\$64,126		
Mammals (baseline inventory 3 VA parks)	\$68,875			
Fish (5 VA parks)	No	Funds	Requested	
Herp Recon. Survey (5 VA parks)	\$4,774			
Herp Inventory (baseline inventory 5 VA parks)			\$85,000*	
Administrative costs				
Network Data Manager		\$52,000	\$23,791**	
Over budget costs from FY01	\$1,282			
Total	\$74,931	\$188,046*	\$108,791*	
I&M Funds Requested	\$74,931	\$188,046*	\$108,791*	

*Estimates-Although the total requested funds exceed the funding allotted to the Network, these figures are only estimates and other funding will be sought to complete projects if necessary.

**This amount may be covered by monitoring funds available to the Network in FY04.

9.3 APPA Budget

Although APPA is part of the Mid-Atlantic Network for inventory purposes, it will receive \$200,000 of its own I&M Program inventory funding and therefore Network funds will not be used for the park.

Table 11. Appalachian Trail Budget for biological inventories.

Project	FY02	FY03	FY04	FY05
Inventory costs				
Data Mining	\$10,000			
Administrative costs				
Cartographic Tech.	\$29,750			
I&M Funds Requested	\$39,750			

LITERATURE CITED

- ASM. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. *Journal of Mammalogy* 79:1416-1431.
- Barry, R. E., K. A. Boyce, and A. C. Sucke. 1999. Local distribution, habitat, and home range of the Appalachian cottontail (*Sylvilagus obscurus*) at Dolly Sods. Final report submitted to the Nongame Wildlife and Natural Heritage Program, West Virginia Division of Natural Resources.
- Bowersox, T.W. and D. S. Larrick. 1999. Long-term vegetation monitoring of forested ecosystems at Hopewell Furnace National Historic Site and Valley Forge National Historical Park. National Park Service Technical Report NPS/PHSO/NRTR-99/077.
- Bowersox, T.W., D. S. Larrick, G. L. Storm and W. M. Tzilkowski. 1997. Regenerated Mixed-Oak historic woodlots at Gettysburg National Military Park and Eisenhower National Historic Site-Phase II. National Park Service Progress Report CA# 4000-9-8004.
- Boyce, K. A. 2001. Distribution, seasonal home range, movements and habitat of the Appalachian cottontail, *Sylvilagus obscurus*, at Dolly Sods, West Virginia. M. S. thesis, Frostburg State University, Frostburg, Maryland.
- British Columbia Ministry of Environment, Lands and Parks, Resources Inventory Branch. 1998. Species Inventory Fundamentals. Standard for Components of British Columbia's Biodiversity No. 1.
- Cummings, J. R., and S. H. Vessey. 1994. Agricultural influences on movement patterns of white-footed mice (*Peromyscus leucopus*). *American Midland Naturalist* 132:209-218.
- Denali National Park data management protocol (1999) and the I&M Program Data Management Protocol (1997)
- Fancy, S.G. and J.R. Sauer. 2000. Recommended methods for inventorying and monitoring landbirds in national parks. Unpublish. Report.
- Fancy, Steven G. 2000. Guidance for the design of sampling schemes for inventory and monitoring of biological resources in National Parks. The National Park Service Inventory and Monitoring Homepage, www.nature.nps.gov/sfancy.
- Fishes.
- Gage, K. L., R. S. Ostfeld, and J. G. Olson. 1995. Nonviral vector-borne zoonoses associated with mammals in the United States. *Journal of Mammalogy* 76:695-715.
- Jones, C., R. S. Hoffmann, D. W. Rice, M. D. Engstrom, R. D. Bradley, D. J. Schmidly, C. A. Jones, and R. J. Baker. 1997. Revised checklist of North American mammals north of Mexico, 1997. Occasional papers, Museum of Texas Tech University 173:1-20.
- Jones, C., W. J. McShea, M. J. Conroy, and T. H. Kunz. 1996. Capturing mammals. Pp. 115-122 in *Measuring and monitoring biological diversity: standard methods for mammals* (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Kirkland, G. L., Jr., and P. K. Sheppard. 1994. Proposed standard protocol for sampling of small mammal communities. Pp. 277-283 in *Advances in the biology of shrews* (J. F. Merritt, G. L. Kirkland, Jr., and R. K. Rose, eds.). Special Publication of the Carnegie Museum of Natural History 18, Pittsburgh, Pennsylvania.
- Krebs, C. J. 1999. *Ecological methodology*. Second edition. Addison Wesley Longman, Inc., Menlo Park, California, 620 pp.
- Kunz, T. H., R. Rudran, and G. Gurri-Glass. 1996. Appendix 2: Human health concerns. Pp. 255-264 in *Measuring and monitoring biological diversity: standard methods for mammals* (D. E. Wilson, F. R.

- Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- McDiarmid, R. W., and D. E. Wilson. 1996. Data standards. Pp. 56-60 in Measuring and monitoring biological diversity: standard methods for mammals (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Mills, J. N., T. L. Yates, J. E. Childs, R. R. Parmenter, T. G. Ksiazek, P. E. Rollin, and C. J. Peters. 1995. Guidelines for working with rodents potentially infected with hantavirus. *Journal of Mammalogy* 76:716-722.
- Mitchell, J.C., S.Y. Erdle and J.F. Pagels. Evaluation of capture techniques for amphibian, reptile, and small mammal communities in saturated forested wetlands. *Wetlands*. 13:130-136. 1993.
- NPFAuna. 2001. Species in parks: flora and fauna database. <http://ice.ucdavis.edu/nps/>.
- NPS. 1996. Inventory and Monitoring Program, Data Management Protocols.
- NPS. 1998. Natural resource inventory & monitoring in national parks. NPS Inventory and Monitoring Informational Brochure. <http://www.nature.nps.gov/im/imb broch.htm>.
- NPS. 1999. Guidelines for Biological Inventories. Inventory and Monitoring Program, NPS. 10 pp.
- NPS. 2000. Guidance for the design of sampling schemes for inventory and monitoring of biological resources in national parks. National Park Service Inventory and Monitoring Program.
- Orrock, J.L., J.F. Pagels, W.J. McShea and E.K. Harper. 2000. Predicting habitat suitability and quality for a small mammal: The effect of scale and resolution. *Ecological Applications*. 10:1356-1366.
- Pagels, J.F. 1987. The pygmy shrew, rock shrew and water shrew: Virginia's rarest shrews (Mammalia: Soricidae). *Virginia Journal of Science* 38:364-368.
- Pagels, J.F., K.L. Uthus and H.E. Duval. 1994. The masked shrew, *Sorex cinereus*, in a relictual habitat of the southern Appalachian mountains. pp. 103-109. In: Proceedings of colloquium, *Advances in the biology of shrews*. J.F. Merritt, G.L. Kirkland, Jr., and R.K. Rose, eds. Special Publication, The Carnegie Museum of Natural History, Number 18.
- Pagels, J.F., S.Y. Erdle, K.L. Uthus and J.C. Mitchell. 1992. Small mammal diversity in forest and clearcut habitats in the Virginia Piedmont. *Virginia Journal of Science*. 43:171-176.
- Primack, R. B. 1993. Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
- Reynolds, R. P., R. I. Crombie, R. W. McDiarmid, and T. L. Yates. 1996. Voucher specimens. Pp. 63-68 in Measuring and monitoring biological diversity: standard methods for mammals (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Rudran, R. 1996. General marking techniques. Pp. 299-304 in Measuring and monitoring biological diversity: standard methods for mammals (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Rudran, R., and M. S. Foster. 1996. Conducting a survey to assess mammalian diversity. Pp. 71-79 in Measuring and monitoring biological diversity: standard methods for mammals (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Rudran, R., and T. H. Kunz. 1996. Appendix 1: Ethics in research. Pp. 251-254 in Measuring and monitoring biological diversity: standard methods for mammals (D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, eds.). Smithsonian Institution Press, Washington, District of Columbia.
- Stauffer, Jay R and T.D. Stecko. 2001. Guidelines for Using Digital Photos as Fish Vouchers for Pennsylvania Storm, G. L., W. M. Tzilkowski, T.W. Bowersox, S. E. Fairweather and R. L. Laughlin. 1995. Plant community development in historic forest stands at Gettysburg National Military Park and Eisenhower National Historic Site. National Park Service Technical Report NPS/MARGETT/NRTR-95/069.

- Tessler, Steven. 1995. Shenandoah NP, Inventory & Monitoring Program, Data Management Plan – Draft.
- Wilson, D. E., and D. M. Reeder (eds.). 1993. Mammal species of the world: a taxonomic and geographic reference. Smithsonian Institution Press, Washington, District of Columbia.
- Wilson, D.E., and S. Ruff (eds.). 1999. The Smithsonian book of North American mammals. Smithsonian Institution Press, Washington, District of Columbia.
- Yahner, R.H., D.S. Klute, G.S. Keller and B.D. Ross. 1999. Comprehensive inventory program for birds at six Pennsylvania national parks: phase II. Annual progress report.
- Yahner, R.H., G. L. Storm, B.D. Ross, and R.W. Rohrbaugh, Jr. 1998. Inventorying and monitoring protocols of birds in national parks of the eastern United States. National Park Service Technical Report NPS/PHSO/NRTR-97/0.
- Yahner, R.H., G. L. Storm, G. S. Keller, B. D. Ross, and R.W. Rohrbaugh, Jr. 1997. Inventorying and monitoring protocols of vertebrates in National Parks of the Eastern United States: Mammals. National Park Service Technical Report NPS/PHSO/NRTR-97/073.
- Yahner, R.H., G. L. Storm, G. S. Keller, B. D. Ross, and R.W. Rohrbaugh, Jr. 1999. Inventorying and monitoring protocols of terrestrial vertebrates in National Parks of the Eastern United States: Hopewell Furnace National Historic Site. National Park Service Technical Report NPS/PHSO/NRTR-00/081.
- Yahner, R.H., G.L Storm, G. S. Keller, B. D. Ross, and R.W. Rohrbaugh, Jr. 1999. Inventorying and monitoring protocols of terrestrial vertebrates in National Parks of the Eastern United States: Valley Forge National Historic Park. National Park Service Technical Report NPS/PHSO/NRTR-00/082.
- Yahner, R.H., K.L. Derge, and Jennifer Mravintz. 2001. Inventory of Amphibians and Reptile Species at Gettysburg National Military Park and Eisenhower National Historic Site. National Park Service Technical Report NPS/PHSO/NRTR-01/084
- Zar, J.H. 1999. Biostatistical analysis. Fourth ed. Prentice Hall, Upper Saddle River, New Jersey.